REPORT ON SURRA

IN

EQUINES, BOVINES, BUFFALOES

AND

CANINES,

TOGETHER WITH AN ACCOUNT OF EXPERIMENTS
CONDUCTED WITH THE

TRYPANOSOMA OF RATS, BANDICOOTS AND FISH,

BY

ALFRED LINGARD,
Bachelor of Medicine and Master of Surgery, Dunelm;
Diplomate in Public Health, Cambridge;
Fellow of the Bombay University;
Professor of Comparative Pathology and Bacteriology,
Civil Veterinary Department, India.

VOL. II, PART I.
With 3 Illustrations and numerous Charts.

BOMBAY:
PRINTED AT THE GOVERNMENT CENTRAL PRESS.

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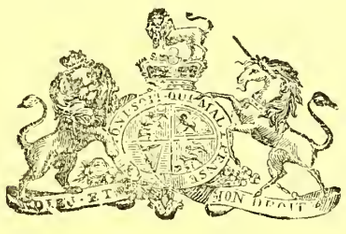
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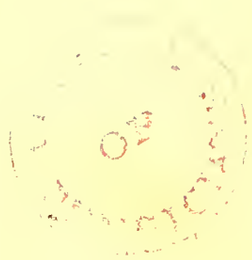


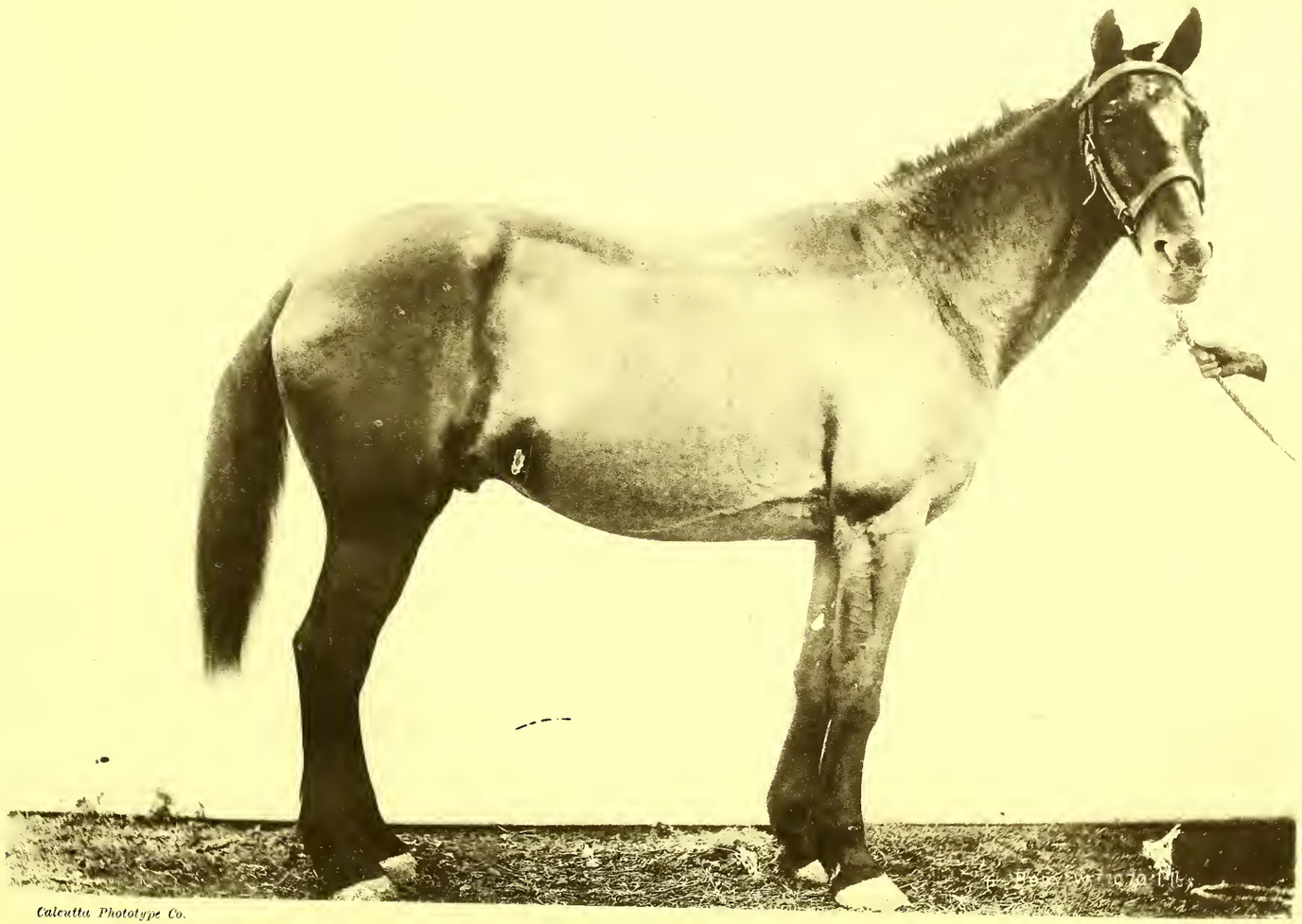
PLATE I.



Calcutta Phototype Co.

HORSE No. LXXXIX.
Shewing the condition of the Animal on the 50th day of Disease.

PLATE II.



Calcutta Phototype Co.

HORSE No. LXXXIX.

Shewing the condition of the same animal, after having undergone successful treatment.

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LIST OF ILLUSTRATIONS.

1. **Horse No. LXXXIX.**—Showing the condition of the animal on the 50th day of the disease ... *Frontispiece.*

2. **Horse No. LXXXIX.**—Showing the condition of the same animal having undergone successful treatment with Arsenic ... ... *Ditto.*

To

VETERINARY-COLONEL A. E. QUERIPEL,
Inspector-General, Civil Veterinary Department, India.

SIR,

I have the honour to submit the second volume of my report on 'Surra.' This includes an account of Surra in Equines, Bovines, Buffaloes and Canines, together with an account of experiments conducted with a view to reproduce the disease in animals by means of soiled blood containing the trypanosoma obtained from rats (*Mus decumanus*), bandicoots (*Mus nesokia giganteus*), and different species of Indian freshwater fish.

The majority of the experiments recorded in this work were conducted during 1891—1893, but Government sanction to print the results obtained was only received in 1895, just at the time preparations were being made for the transference of the Laboratory from Poona to Muktesar, Naini Tal District. Unfortunately since that date, owing to pressure of work, it has only now been found feasible to complete the manuscript, but owing to the delay much additional information with regard to Surra in different animals has been obtained and added, which otherwise would not have been forthcoming.

The charts showing the records of temperature, water taken, urine passed and total urea excreted, &c., in connection with certain researches initiated in 1893 with regard to physiological and pathological observations in equines during a period of health and disease (Surra), have been in some instances included in this volume.

In the event of the Government of India considering the subject to be of sufficient importance to sanction the appearance of a third volume, the whole question dealing with the above subject and the remaining charts will appear in it, together with an account of the minute pathology of the disease and the life history of the *trypanosoma*.

I wish again to convey to the following officers and gentlemen my sincere thanks for the information regarding Surra which they have been good enough to communicate to me, and to Brigadier-General W. F. Gatacre, C.B., D.S.O., late Adjutant-General, Bombay Army, Colonel T. Deane, Director, Army Remount Depôt, Messrs. Vincent, Rimington and Buckland for the horses and foxhounds, &c., they kindly placed at my disposal for the purposes of observation and treatment :—

R. H. Vincent, Esquire, C.I.E., Commissioner of Police, Bombay.

Veterinary-Major J. Mills, Principal, Bombay Veterinary College.

Veterinary-Captain H. T. Pease, Principal, Lahore Veterinary College.

Veterinary-Captain G. H. Evans, Superintendent, C. V. D., Burmah.

Veterinary-Captain S. M. Smith, A. V. D., Remount Depôt, Saharanpur.

Veterinary-Lieutenant F. Eassie, A. V. D., Karnal Government Remount Depôt.

Veterinary-Lieutenant Loughlin, A. V. D., late Superintendent, C. V. D., North-Western Provinces.

Veterinary-Lieutenant T. G. Peacocke, A. V. D., Karnal Government Remount Depôt.

H. W. Buckland, Esquire, late M. F. H., Bombay.

F. C. Rimington, Esquire, Managing Director, Bombay Tramway Company.

A. Leslie, Esquire, Bombay.

Mr. N. D. Dhakmarwala, Assistant Principal, Bombay Veterinary College

Mr. Judah Hyam, G.B.V.C., in charge of the Poona Veterinary Hospital.

To Mr. M. K. Bamber, Member of the Royal Agricultural College, and late Assistant to the Imperial Bacteriologist, my special thanks are due for the assistance rendered to me during my researches into the etiology and treatment of Surra between 1893—1896.

I have the honour to be,
Sir,
Your most obedient Servant,

ALFRED LINGARD,
Imperial Bacteriologist.

EXPLANATION OF TERMS, &c.

The first day of the disease is that upon which the Surra hæmatozoon is present in the blood, either when contracted naturally, or as the result of inoculation.

. . Petechiæ ... } These are used as synonymous terms.
Ecchymosis ... }

• • Some diameters have been given as equivalent to that of a rupee, eight, four, and two-anna pieces. The following are their measurements in inches and in centimetres :—

Rupee	= 1·25 inches	= 3·17 centimetres.
Eight-anna	= 0·375 „	= 2·38 „
Four „	= ·750 „	= 1·904 „
Two „	= ·625 „	= 1·58 „

The terms 'Hæmatozoon' and 'Organism' have reference to the infusorian found in the blood of horses, the subjects of Surra, if not otherwise defined.

The terms and abbreviations Absent (A.), Few (F.), Numerous (N.), Very Numerous (V.N.), and Swarming (S.) have reference to the number of hæmatozoa present in each cover-glass specimen of blood, examined microscopically.

F. = From one hæmatozoon in a cover-glass preparation of blood to five hæmatozoa in a field of the microscope.
N. = „ five „ „ „ to twenty in each field.
V.N. = „ twenty „ „ „ to fifty in each field.
S. = Above fifty

Zeiss object D, ocular 4 with the tube in, being employed.

Variation of temperatures of animals in health at the Laboratory :—

Horse—Normal limits between		99·0°F. and 101·0°F.	= 37·2°C. and 38·3°C.
Donkey—	„ „	96·4°F. and 97·8°F.	= 35·8°C. and 36·6°C.
Ox—	„ „	100·0°F. and 101·0°F.	= 37·7°C. and 38·3°C.
Sheep—	„ „	103·0°F. and 104·7°F.	= 39·4°C. and 40·0°C.
Goat—	„ „	101·8°F. and 104·3°F.	= 38·8°C. and 40·2°C.
Dog—	„ „	98·6°F. and 103·6°F.	= 37·0°C. and 39·8°C.
Cat—	„ „	98·6°F. and 101·5°F.	= 37·0°C. and 38·6°C.
Rabbit—	„ „	101·8°F. and 103·6°F.	= 38·8°C. and 39·8°C.
Guinea-pig—	„ „	101·1°F. and 103·0°F.	= 38·4°C. and 39·4°C.
Fowl—	„ „	105·8°F. and 108·7°F.	= 41·0°C. and 42·6°C.
Pigeon—	„ „	105·8°F. and 109·4°F.	= 41·0°C. and 43·0°C.

The temperatures of the large animals were taken three times daily—between 7 A.M. and 8 A.M., 1 P.M. and 1-30 P.M., 5 P.M. and 6 P.M.; that of the smaller animals and birds usually twice daily—8 A.M. and 5 P.M.

Precautions observed before taking blood from an animal for experimental purposes.

The part was carefully washed with soap and water, and subsequently with a solution of Mercuric Perchloride, 1 in 1,000.

Each animal had a lancet, ticketed with its number, assigned for the purpose of blood-letting; this instrument was specially kept for this animal alone, and after use was boiled for a period of ten minutes before being used again for the same animal.

The person collecting specimens of blood from the affected animals for microscopical examination in each instance washed his hands carefully after handling one and before proceeding to another animal. This precautionary measure was adopted on the 15th January 1891, and has been since carried out.

For the purposes of record, the blood of the experimental animals and birds was subjected to microscopical examination once daily in the morning, unless points of interest made it necessary to make observations later in the day.

Blood.—In investigating the condition of the blood of the experimental animals and birds in all cases, since the commencement of this enquiry, two large cover-glass preparations have always been taken daily from each animal, and submitted to careful microscopical examination. If there was doubt on any point, or interesting details had to be cleared up, further specimens of blood were obtained and noted as required.

Pathological conditions found at the Autopsies.

In numerous instances in horses caseous bodies or masses have been described as having been found invading the tissues of the lungs and liver. These bodies are due to pathological changes which have taken place at a period antecedent to that when the animal became the subject of acquired or inoculated Surra.

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SECTION I.

Nomenclature.

In almost every district a different vernacular name is given to this disease, for instance in Rájputána the disease in camels is known by three distinct names, *viz.* "*Tebersa*" meaning "three years duration," "*Sukul*" and "*Galtia*" from the fact that one of the symptoms is rapid wasting, "drying up" or "melting away" of the animal's body.

The following is a list of the vernacular names of this disease in different parts of the country, as far as at present ascertained. In addition English equivalents have been added, with a view to convey an idea as to the literal meaning of the native terms. The inhabitants all over India generally name a disease after the most prominent symptom of the malady observed in their locality, but it is by no means easy at times to find the corresponding word in the English language so as to exactly convey the correct meaning expressed by the vernacular term :—

India.

Name of Province.	Name of District.	Vernacular Names.	English Equivalents.
Punjab ...	Delhi	Zaharbad, Phenta, Sokra, Oal ...	Zaharbad = Blood-poison. Phenta = Fatal. Sokra = without flesh and blood (skeleton).
	Rohtak	(Camel Surra) Tebersa, Purana, and Nikalgaya.	Tebersa = Three years' duration. Purana = Used up. Nikalgaya = Passed away (hopeless).
	Hissar	Gokra (in camels).	
	Karnal	Phenta, Pheta-ká-darad, Tarai ; Phitgaya (in camels).	Tarai = Wet, moist.
	Umballa... ...	Phenta, Phera	Phera = Bursting of abscess.
	Ludhiana ...	Zaharbad, Phenta; Purana (in camels).	
	Jallandher ...	Táp, Sokra, Zaharbad, Tap-dik ...	Táp = Fever.
	Hoshiarpur ...	Wabai-ki-bokhar, Tap, Sokra, Zaharbad.	Wabai-ki-bokhar = Epidemic fever.
	Ferozepur ...	Tap, Andar-tap, Phenta, Marri, Soka, Tapé-dik, Sara, Sokra; Tebersa (in camels).	Andar (within the body) Tap (fever). Marri = Plague. Sara = Rotten, foul.
	Amritsar... ...	Sokra, Gum-Zaharbad	Gum (concealed) Zaharbad.
	Lahore	Sokra, Zaharbad.	
	Gurdaspur ...	Sokra, Khusk-Zaharbad... ...	Khusk (dry) Zaharbad.
	Gujranwala ...	Pheta, Sokra	Pheta= Fatal.
	Jhelum... ...	Sokra.	
	Dera Ismailkhán ...	Sár, Camel Surra called Khanhog, Doaia, Phipri and Surra.	Sár = Rotten. 1st stage Khanhog = Refusing food. 2nd stage Doaia = Swelling over the chest. 3rd stage Surra = Rapid waste.
	Mooltan	Sár.	
North-West Provinces.	Saharanpur ...	Pheta, Photra	Photra = Abseess.
	Muzaffarnagar ...	Phetra	Phetra = Do.
	Meerut	(Camel Surra) Purana, Phitgaya ...	Phitgaya = Gone phut (burst).
Bombay ...	Broach	Berbad	Berbad = On wind, wasted away, or spoilt.
	Baroda and Gujarát ...	Zherbad	Zherbad = Poisonous wind or Miasma.
Rájputána ...	Bikanir	(Camel Surra) Tebersa, Sukal and Galtia.	Sukal = Drying up. Galtia = Melting away.
		Galtah	Derived from Gala, meaning throat, as Gaitah is a form of Surra in camels in which the throat affection is one of the prominent symptoms.
Throughout	Rájputána ...	Tebersa.	
In	Burma	Thut.	
South	Afriea	Nygana.	Tsetse fly disease.
	Congo	La mouche.	

SECTION II.

Geographical Range.

As stated in Surra Report, Volume I, the geographical range of this disease is much wider than was once imagined.

Among the first recognised districts in India were Dera Ismail Khán on the North-Western Frontier, east of the Indus, where the disease has been known for generations, Asni near Rájanpur, Kohat, Upper Burmah, the Island of Bombay, Konkan, Meerut in the North-West Provinces, in the Berárs, and in

Cachar and Assam. It was also reported from the Persian Gulf, Persia and Tonquin. There were also strong reasons for believing that animals have succumbed to this disease in Abysinnia, the Zambesi, East Africa, Australia, North America, Brazil and Southern Europe.

Since the publication of the above report numerous fresh centres have been brought to light. Out of the thirty-one districts in the Punjab, Surra has been found up to the present to be enzootic in twenty-two, the worst being the Karnal District. In the North-Western Provinces the disease has been observed in the Saharanpur, Muzzafarnagar, Meerut, Bulandshahar, Gaziabad and Fyzabad Districts; in the north-east portion of the Jalpaiguri District, Bengal. In addition widespread outbreaks have occurred in the Ahmedabad, Baroda and neighbouring localities which have carried off thousands of equines. Spontaneous cases of Surra have also been recognized in Lower Burmah, Rájputána and Bikanir. One horse also arrived in Bombay from the Persian Gulf suffering from Surra.

In other parts of the world the *trypanosoma* has been reported from Algeria (Equines), France (Bovines), Korea (Equines and Bovines), Egypt and Syria (Equines), while in Zululand a *trypanosoma* has been observed in the blood of equines, bovines and canines, which is indistinguishable microscopically from the flagellated protozoon found in the circulation of animals in India.

SECTION III.

OUTBREAKS OF SURRA.

A.—In India and Burmah.

B.—In other Countries.

The following accounts of outbreaks of Surra in different parts of the Indian Empire have been collected since the appearance of the first Surra Report in 1893. In addition extracts of some papers published have been added dealing with cases which have occurred in other countries than those included in the above notice.

Unfortunately much literature which may bear on this subject remains unexamined, as the published works can only be consulted in European libraries.

In dealing with Surra in the Punjab a short account of each district has been added, in order to give a general idea of the physical characters of the country in which the disease is found, to those readers who are not acquainted with our Indian possessions. This information has been collated from the Gazetteers published by Government during the past twenty years.

A.—In India and Burmah.

Punjab.

Gurgaon District.

This district lies in the extreme south-east corner of the Punjab. It is very irregular in shape and offers considerable variety in physical conditions, climate and soil. It lies at an elevation of 600 to 700 feet above the level of the sea.

It is divided into five tahsils, *viz.* Gurgaon, Firozpur, Nuh, Palwal and Rewari. The Gurgaon and Rewari tahsils, forming the northern and western parts of the district, are generally sandy, the lands lying near the hills are very inferior and very much cut up by ravines; further from the hills the soil is better and approaches a light loam in its character; in some parts it presents a desolate appearance of high hillocks of sand. To the south-east and south-west of Gurgaon is the low basin of the Najafgarh Jhil. The banks of the Jumna which bound the district on the east are generally high, but in the north-west corner of the Palwal Tahsil there is a small tract between the main and a small branch channel of the river low-lying and liable to inundation. From the Jumna and this tract westwards there is a stretch of country some 30 to 35 miles from north to south and 15 to 20 miles from east to west of a level good loam gradually rising from the Jumna and then sloping to the east and south and extending over most of the Palwal Tahsil and eastern portions of Nuh and Firozpur tahsils. This is now much cut up by canals and is for the most part irrigated in the Palwal Tahsil. Between this plain and the range of hills dividing Gurgaon from Ulwar there is in Nuh a low-lying tract of country which is the receptacle for the drainage of the Firozpur valley and parts of Ulwar to the south, of highlands just mentioned to the east, of the hills that lie on the sides of the Bhundsi valley to the north, and of the eastern slopes to the west. In this part of the country the prevailing soil is clay excepting in the immediate vicinity of the hills, where it is very sandy, as it is also to the north-east of Nuh and in the north-west of Palwal. The part of Nuh which lies above the hills is a high lying tableland of consistent but sandy loam. The part of Firozpur not contained in the plain consists of a valley between two ranges of hills.

The marked physical characteristics of the district are found in its *Jhils* or lakes and the hill ranges which are connected with the great Aravali chain, of which they are among the most northern spurs.

The district comprises an area of 1,938 square miles with a population of 641,848 souls.

The average rainfall of the tract may be taken at about 25 inches, the average in each tahsil being—Gurgaon 26·6, Rewari 22·4, Nuh 24·0, Palwal 25·5 and Firozpur 22·3 inches annually.

The flooded tracts near Nuh are terribly fever-stricken in years of abundant rainfall, and a few men can stand a lengthened residence at Nuh without injury to their constitution. The higher parts

of the district, and notably the Tárorú tableland, and the high plain of Palwal and the east of Nuh and Firozpur, used to be very healthy; but fever has come with the Agra Canal into the villages along its course in the high plain. Fever is the chief cause of mortality.

Firozpur Tahsil—One outbreak of Surra, in a village of this tahsil, is reported to have carried off cent per cent. horses and asses possessed by the villagers.

Nuh Tahsil.—In a village of this tahsil all the horses owned by the villagers succumbed to the disease during August 1896.

Delhi District.

This district is the central of the three districts of the Delhi Division. It consists of a long narrow strip of country running along the western bank of the Jumna. It is divided into three tahsils, of which Ballabhgarh lies to the south, that of Delhi in the centre, and that of Sonepat to the north. It embraces an area of 1,276 square miles and has a total population of 643,515 souls.

Hills divide the district into two parts, the highest point of the range near Bháti 1,045 feet above the sea and 360 feet above the Jumna at Delhi. The northern part, which is larger, is also the more fertile and more populous. Without going minutely into details it may be said that this larger half of the district consists of three parts,—the Khádar or riverain of the Jumna; the Bángar or level mainland is higher, but the Western Jumna Canal traverses its whole length and affords too copious irrigation; the Dábar or lowland subject to floods for many miles round Chháoleh. The Khádar lies rather low, has a light sandy soil, and easy irrigation from wells.

The average rainfall from 1866—1879 in the different tahsils was: Delhi 25·5, Ballabhgarh 21·3, and Sonepat 23·1 inches.

"The existence of reh (saline efflorescence) and its extensive impoverishment of the soil are too well-known to require to be dwelt on at length."

"The sanitary condition of most of the villages is as bad as it can possibly be. Each village is surrounded by dung hills, and by one or more stagnant pools. In most houses the families and the cattle sleep in the same quarters, and the water of the wells is frequently brackish, or largely impregnated with organic matter. The district has seldom been visited by cholera, and the mortality from this disease has never been very high, but the villages and smaller towns suffer greatly from periodic epidemics of fever which cause great mortality.",—(District Census Report, 1881).

Cattle form an important feature of the agricultural economy of the district, but numerous sheep and goats are also kept by the villagers. The last returns show that there are only 2,636 horses in the district.

Delhi Tahsil.—During July 1891, one village of this tahsil is said to have suffered from Surra, losing one horse only. An outbreak took place amongst cavalary horses when marching through Delhi in 1894-95; one squadron was left behind.

Ballabhgarh Tahsil.—In Kurnali, which lies near the Jumna, Surra appeared in the rains of 1893 and killed off all the horses and asses in the village. Since then no equines have been kept. The Lambardár lost four horses, for which he had paid Rs. 250 each.

Sonepat Tahsil.—Surra called "Zaharbad" occurred in seven villages of this tahsil, situated in the Jumna Khadar, during the latter half of 1895. During the month of November 1895 another village of the tahsil suffered from this disease (sometimes called "Oal").

Reports submitted with regard to the outbreaks of Surra during recent years, *viz.* 1892—1896, in seventeen villages situated in this tahsil. The loss sustained was slight in comparison to those in the bordering district of Karnal; only 48 horses, 38 mules and 8 asses succumbed.

"As might be expected from the similarity of the physical characters of the Khadar lands of the Delhi and Karnal districts and their contiguity, Surra is found to be a serious fatal disease to equines in the Khadar tract of the Jumna in that district. I heard numerous complaints as to the whole of the horses having been carried off some years ago by a plague which from a description of the symptoms appears to have been undoubtedly Surra, and I consider the whole of the tract dangerous. Whilst visiting Karali on my tour I was informed that all the soliped animals in the village had been carried off a few years ago and that the people were afraid to get more animals there. The Lambardár had purchased a mare and wanted my opinion as to whether there was any chance of her living".—(Veterinary-Captain Pease).

Rohtak District.

This district lies to the immediate west of the Delhi District. Its centre is about 730 feet above sea level, and the fall of the country from north to south is about one foot per mile. It embraces an area of 1,811 square miles with a population of 553,609 souls. It is divided into four tahsils, of which that of Gohána comprises the northern, Jhajjar the southern, Sampla the east central, and that of Rohtak the west central portion of the district. The seasons are notoriously uncertain in their character, the average rainfall for the 18 years 1866—1883 being 20 inches. "The eastern border of Rohtak lies low, at the same level as the Delhi branch of the Western Jumna Canal and the Najafgarh Jhil, to which the streams of the Sahibi and Indori pass across the eastern corner of Jhajjar. A few miles from the east border, taken at the centre of the district, the surface rises gradually to a level plateau, which, speaking roughly, stretches as far as the town of Rohtak, and is in a manner demarcated east and west by two rows of sand-hills. Beyond the western line the surface slopes up again, till it ends on the Hissár border in a third high range. The depth of the water below the surface in the wells of those villages which are removed from the influence of the canals and streams, testifies clearly to the general exterior configuration of the country. Along the whole east border the depth to the water is 28 feet; at a distance of ten miles from the Delhi boundary, and along a line drawn from below the canal village of Gánwir in Gohána, Khimgái in Jhajjar, the average depth is

67 feet; down the centre of the district from the town of Rohtak to Gwálesan the depth is 67 feet also; at a distance of 7 to 9 miles from the western border, the water is 80 feet below the surface, and along the western boundary of the Rohtak Tahsil 115 feet."—(Gazetteer). Irrigation from tanks is never practised; the people have religious prejudices against this.

Equines.—Till quite recently, no village headmen used to possess horses; most of the ponies belong to traders, &c. Asses belong entirely to the potters; camels are owned by a class called 'Rhábaris.'

Reh.—Saline efflorescence, called *shor*, is unfortunately not unknown, although it has not developed along the canals in Rohtak so badly as in Delhi and Karnal; it occurs chiefly in Mahmúdpúr and a few other villages above Mahmúdpúr in the north-east of the Gohána Tahsil, round Kharkhándah, and above the town of Rohtak. The evil in nearly all of these cases is caused by obstructions to the natural drainage lines.

Health.—Stone in the bladder is common, as well as guinea-worm, along the irrigated tracts. Intermittent fever and ague are common, with their sequelæ, enlargement of spleen, dropsy, and anæmia. Pneumonia is fatally prevalent throughout the autumn and winter, owing chiefly to the extreme range of temperature during the twenty-four hours.

Jhajjar Tahsil.—At the end of 1894, Surra appeared in the village of Aurangpur, Nangala and Dadri in the Jhajjar Tahsil of this district; fifteen ponies died in the three villages in November. The country around is known as the Dábar, on account of the inundation and swamps. Ponies are very few there.

In this district the disease is well known to the natives as "Tebersa," "Purana" or "Nikalgaya" affecting camels.

Veterinary-Captain Pease remarks:—

"This disease appears occasionally, but it is naturally not very widespread owing to the very few number of horses which are to be found in the district. It is found in the villages where the land is liable to inundation such as the 'Dabar,' also amongst the camels where the tank water evaporates and gets foul and thick."

"The duration of the disease in camels may be gathered from its name 'Tebersa' which signifies three years disease, and the people say that if the animal lives for that time recovery is certain."

Karnal District.

This district consists of a tract of plain country lying on the right bank of the Jumna, including a portion of the valley of that river and stretching away westwards across the Sarusti and Ghagar into the eastern plains of the Punjab. It embraces an area of 2,579 square miles, and has a population of 645,219 souls. It is divided into three *tahsils*—Panipat, Karnal and Kaithal—the southern, central and north-eastern, and western and north-western portions of the district respectively.

The district is everywhere flat, and lies about 780 feet above the sea, the height probably nowhere differing from this figure by more than some 30 feet. There is a very gradual fall from the north-east to the south-west.

The distance of the water table from the surface is much affected by the Western Jumna Canal and the river; in their vicinity it is seldom greater than 15 feet, and often not more than 2 or 3 feet. The soil varies from stiff loam to pure sand; the stiffest "dakar" being found in the hollows and drainage lines, whilst the sandy soil "bhuda" is found chiefly in patches, lying in the beds of old river channels.

Physical character of the Surra Zone.—The Khadir, Bangar, Nardak and Naili are terms applied to different areas in the Karnal District according to certain physical characters.

The Khadir is a low-lying riverain tract, with light soil, and water close to the surface; often flooded by the Jumna, which bounds it on the east, rendering it practically impassable for miles.

The Bangar.—This tract lies to the west of the Khadir, and is elevated some few feet above it, by a plainly marked bank or drop. It is watered almost throughout its area by the Western Jumna Canal and is for the most part a sheet of cultivation interspersed with great swamps and large barren plains covered with saline efflorescence. The cultivated land is subjected to excessive irrigation by the natives with the result that the whole country is water-logged, and after heavy rain flooded for miles. At the termination of the rains vegetation undergoes putrefaction, and malarial fever and splenic disease become very prevalent, about 65 per cent of the deaths being due to malaria alone.

The Nardak is a high arid tract of tableland, lying to the west of the Bangar, with water at great depths, and having little irrigation. It is conspicuously a grazing country, the land being covered with Jal, Jand and Kair, and affording excellent pasturage in years of good rainfall.

The Naili.—This is the name given to the unhealthy country north of the Kaithal Tahsil, inundated by the floods of the Sarusti, Umla, and Ghagar rivers. Some of the land is cropped when dry enough, but it for the most part remains swampy and is covered thickly with sedgy grasses.

The average rainfall from 1866 to 1889 in the different tahsils was—Karnal 30", Panipat 24·5" and Kaithal 18·7".

With the exception of the Nardak the whole district is exceedingly unhealthy, especially during the rains, Black quarter (*charbon symptomatique du bœuf*) and "Ghotwa" or throat disease being very prevalent among cattle, causing considerable loss annually.

"Pheta" (Surra) caused its ravages during the rains of 1895 in 72 villages visited by Veterinary-Captain Pease. The disease occurred in many other villages, especially in those in the Khadar (132 in number) and Naili (64 in number) where it is said to occur annually; but as so few horses are kept, the donkey and ponies belonging to the Kumhárs (potters) only are attacked, and their loss does not attract much attention. The losses from Surra in sixteen (16) villages in the above tahsil, when statistics were forthcoming, were 48 per cent. horses, 40 per cent mules and 44 per cent. asses.

Many of the villages lost, in addition, a great number of their dogs from this disease; in some there was scarcely one remaining. The canines appear to have contracted the malady through eating diseased carcasses.

It was thought to be more than likely that the villages in the Indri and Pipli Tahsils, sustained severe losses from the same causes as the above mentioned—the former lying between the Western Jumna Canal and the Jumna river, the latter on the border of the Amballa. Surra is known to be enzootic in the latter locality. Surra has been most prevalent in the north-east corner of the Karnal District, part of the Karnal Tahsil lying in the angle formed by the Umballa-Karnal and Karnal-Meerut roads, that is, between 77° and 78° longitude, and 29° 50″ and 30″ north latitude.

In this locality alone no less than 10 villages are known to have suffered very considerable losses. The general opinion, however, is that nearly all the villages in this tahsil have suffered more or less from the ravages of this disease.

During the season 1896 the rainfall was considerably under the normal quantity, consequently the outbreaks of this disease are very few in comparison with those recorded after a wet monsoon. Three villages are reported to have suffered from the malady losing eleven horses.

In September 1896 the Surra hæmatozoon was found in the blood of two mares at the village of Tikri some four miles from the Government Depôt, Karnal.

During August and October 1896 two villages of the Karnal Tahsil suffered from Surra, losing a couple of horses.

During October and November 1897 Surra was reported to be present in the town of Karnal and several of the surrounding villages.

"The name by which this plague is known here is 'Phenta' or 'Pheta-ka-dard;' in some parts of the district it is spoken of as 'Tarai,' whilst camels affected are said to be 'Phitgaya.'—(Captain Pease).

Report on an outbreak of Surra at Karnal Remount Depôt.

At the latter end of the year 1895 Surra broke out amongst the horses and bullocks of the Government Remount Depôt, Karnal. Fever of an intermittent type was also present among the animals. It appeared alone, as well as complicating most other disorders, following operations, and even simple punctured wounds. In the Surra cases the temperatures were changed from the ordinary type. It was further ascertained that the Karnal fever is capable of being reproduced in healthy animals by inoculation of soiled blood. Nineteen horses in all succumbed to symptoms of Surra, in nine of which the *trypanosoma* was microscopically demonstrated. The rains in 1895 were unusually early, 11·62 inches falling in June. The first cases of the disease probably occurred on the 30th August and the first death on the 20th September 1895, the last case to succumb being on January 8th, 1896. All the Surra cases with two exceptions had been inmates for varying periods of one or other of Paddocks II, III and V; the two remaining animals, farm cart horses, occupied with others both Paddosks III and V. The majority of the cases in which the organism was not examined for microscopically, are said to have succumbed to fever, fever and lymphangitis and debility, and all were taken ill and died during the Surra months, so that it is more than probable that had the blood of any or all of them been microscopically examined, the organism of Surra would have been found. On the 15th December the Surra organism was discovered in the blood of two Hissar bullocks. One of these animals, with a daily variation of 10° F. in the temperature recorded, succumbed, the second survived and was alive two years later. In both these cases Surra was complicated with Filariasis and intermittent fever.

The Depôt Estate was part of one continuous plain, and for years had been intersected by roads, but the soil and conditions are nearly the same throughout. In some portions of the land, especially Paddock II, the appearances in December show that during the rains it is subjected to inundation, the land being water-logged and boggy, where grasses of the rankest description thrive. There are numerous ponds about the Depôt, but the largest and most important is in Paddock II. In the water from this tank infusoria were very numerous, and occasionally nematode eggs, while in one specimen a species of Acarus was demonstrated.

Certain suggestions were submitted with a report dealing with the cause of the diseases present on the Depôt Estate, chief among which were the following. The filling in and enclosing of all ponds was paramount, to be followed by the free drainage of all Paddocks which were water-logged. All irrigation in the Depôt was pointed out as undesirable, and it was doubtful whether ploughing certain paddocks would improve matters. Most of the above improvements were carried out and for the past two and a half years no further cases of Surra have occurred in equines or bovines.

TABLE I.

Karnal animals which succumbed to Surra.

Serial No.	Veterinary case No.	Karnal No.	Stable No.	Colour.	Sex.	Age. Years.	Age. Months.	Date of Admission to Hospital.	Date of death.	Disease.	In Hospital. From	In Hospital. To	No. of Stable attended to.	Date. From	Date. To	No. I Paddock. From	No. I Paddock. To	No. II Paddock. From	No. II Paddock. To	No. III Paddock. From	No. III Paddock. To	No. IV Paddock. From	No. IV Paddock. To	No. V Paddock. From	No. V Paddock. To
								D. m. y.	*D. m. y.*		*D. m. y.*	*D. m. y.*		*D. m. y.*	*D. m. y.*	*D. m. y.*	*D. m. y.*	*D. m. y.*	*D. m. y.*	*D. m. y.*	*D. m. y.*	*D. m. y.*	*D. m. y.*	*D. m. y.*	*D. m. y.*
1	811	1910	VI	Grey.	Mare.	4	6	27 10 95	26 11 95	Paralysis Surra, 19th Nov. 1895.	7 9 95	23 9 95	...	.....	.....	1 1 95	30 6 95	30 6 95	7 9 95	...	.....	.....	.....	23 9 95	27 10 95
2(*a*)	846	1220	Supt.	Grey.	Gelding.	5	7	2 11 95	19 12 95	Surra ...	19 10 95	25 10 95	...	.....	.....	.....	.....	.....	.....	...	.....	.....	.....	.....	...
3	855	1321	VII	Bay.	Mare.	4	3	5 11 95	25 11 95	,, ...	.....	.....	VII	28 10 95	5 11 95	1 1 95	30 6 95	30 6 95 8 10 95	7 9 95 21 10 95	...	.....	.....	.....	7 9 95 21 10 95	8 10 95 28 10 95
4	857	169	III	Bay.	Mare.	2	7	5 11 95	14 12 95	,, ...	20 5 95 10 9 95	28 6 95 5 11 95	...	.....	.....	.....	.....	30 7 95	7 9 95	30 6 95	30 7 95	3 5 95	30 6 95	7 9 95	10 9 95
5	864	990	1	Chestnut.	Mare.	4	8	6 11 95	19 12 95	,, ...	17 10 95	21 10 95	I	1 11 95	6 11 95	.....	.....	1 1 95 8 10 95	7 9 95 1 11 95	...	.....	.....	.....	7 9 95	8 10 95
6	866	1007	II	Chestnut.	Mare.	4	6	7 11 95	9 12 95	,, ...	7 10 95	7 11 95	II	.....	.....	.....	.....	1 1 95	7 9 95	...	.....	.....	.....	7 9 95	7 10 95
7(*b*)	887	644	Farm.	Bay.	Mare.	9	6	12 11 95	19 11 95	,, ...	...	.....	...	.....	.....	.....	.....	.....	.....	...	.....	.....	.....	.....	...
8	948	69	III	Bay.	Gelding.	2	7	23 11 95	16 12 95	,, ...	.....	.....	...	.....	.....	.....	.....	30 7 95	7 9 95	30 6 95	30 7 95	21 5 95 6 10 95	30 6 95 23 11 95	7 9 95	6 10 95
9	966	1645	III	Bay.	Gelding.	3	8	28 11 95	4 12 95	,, ...	17 11 95	22 11 95	...	.....	.....	.....	.....	30 7 95	7 9 95	30 6 95	30 7 95	1 1 95 6 10 95 22 11 95	30 6 95 17 11 95 28 11 95	7 9 95	6 10 95
10	1022	1952	V	Grey.	Gelding.	3	3	12 12 95	23 12 95	,, ...	.....	.....	...	.....	.....	.....	.....	.....	.....	...	.....	.....	.....	I 1 95	12 12 95
11	1045	1847	IV	Bay.	Mare.	3	3	24 12 95	8 1 96	,, ...	21 8 95 18 12 95	11 10 95 24 12 95	...	.....	.....	.....	.....	30 7 95	21 8 95	30 6 95	30 7 95	1 1 95 11 10 95	30 6 95 18 12 95	.....	...
12	581	139	III	Chestnut.	Mare.	2	6	30 8 95	20 9 95	,, ...	.....	.....	III	.....	.....	.....	.....	30 7 95	30 8 95	30 6 95	30 7 95	30 4 95	30 6 95	.....	...
13	582	138	III	Chestnut.	Mare.	2	5	30 8 95	2 11 95	,, ...	29 4 95	17 6 95	..	.....	.....	.....	.....	30 7 95	30 8 95	30 6 95	30 7 95	29 6 95	30 6 95	.....	...
14	628	153	III	L. Grey.	Gelding.	3	5	14 9 95	3 11 95	,, ...	17 4 95	25 5 95	III	.....	.....	.....	.....	30 7 95	7 9 95	30 6 95	30 7 95	25 5 95	30 6 95	7 9 95	14 9 95
15	639	185	III	Chestnut.	Gelding.	2	1	17 9 95	20 10 95	,, ...	6 8 95	4 9 95	III	.....	.....	.....	... ..	4 9 35	7 9 95	...	.....	.....	.....	7 9 95	14 9 95
16	759	1325	1	Bay.	Gelding.	4	7	6 10 95	28 10 95	,, ...	6 3 95 8 10 95	25 3 95 16 10 95	I	.....	.....	I 1 95	30 6 95	30 6 95	7 9 95	...	.....	.....	.....	7 9 95	8 10 95
17 (*c*)	818	1197	Farm.	Grey.	Mare.	3	8	28 10 95	5 11 95	,, ...	.....	.....	Farm.	.....	.....	.....	.....	.....	... ..	...	.....	.....	.....	.....	...
18	838	79	II	Bay.	Filly.	9	7	31 10 95	15 11 95	,, ...	7 9 95	27 10 95	I	.....	.....	.....	.....	20 3 95 27 10 95	7 9 95 31 10 95	...	.....	.....	.....	.....	...
19(*d*)	845	842	Farm.	Mouse.	Mare.	5	8	2 11 95	4 11 95	,, ...	.....	.....	Farm.	.....	.....	.....	.....	.....	.....	...	.....	.....	.....	.....	...

(*a*) This horse was admitted to Hospital from the Superintendent's stable direct. It had not been turned out to graze during the last year. Ridden regularly by the Superintendent on his rounds.

(*b*) Grazed in No. 14 stackyard from January to May, June, July and half of August in No. V Paddock. Half August and September in No. III Paddock. Returned to Bullock Shed in October, afterwards tied up in No III. Admitted to Hospital 13th October 1895 to 27th October 1859. Then worked in water cart until sent to Hospital, 12th November 1895.

(*c*) Grazed in No. 14 stackyard from January to May. During June, July and part of August in No. V Paddock. Part of August and September in No. III Paddock. October tied up in Bullock Shed and then sent to Hospital to work in Hospital cart.

(*d*) Grazed in No 14 stackyard from January to May. During June, July and part of August in No. V Paddock. Part of August and September in No. III Paddock. Returned to Bullolk shed in October. Worked in Parching Shed cart till admitted to Hospital.

Ambala District.

The Ambala District comprises two detached blocks of country lying between the Jumna and the Sutlej, and is divided into six tahsils, of which four (Ambala, Naraingarh, Jagadhri, and Pipli) are included in the larger block, covering the southern and eastern portions of the district, the remaining two (Kharar and Rupar) running up to the Sutlej in the extreme north-west. It includes an area of 2,412 square miles and has a population of 1,033,427 souls.

The height above sea-level ranges from 800′ to 1,000′ and the district is usually described as submontane, which is correct as regards the Rupar, Kharar, Naraingarh and Jagadhri tahsils; but in the southern portion of the district, including the greater part of the Pípli Tahsil, and a large part of Ambala, the hills are low, bleak and generally devoid of vegetation other than rough scrub. The soil is chiefly stiff clay, and the face of the country is broken with huge tracts of dhak jungle, and the depth of water below the surface varies from 9′ to 24 feet, in the Khadir 9′, Bet Markanda 18′, and Bangar 24′. Irrigation is carried out in Pipli from the Western Jumna Canal, wells, and *kacha* tanks, but as a whole the district is essentially dependent on the rain for its crops, the normal amount for the Pipli Tahsil being 24 inches. The rainfall is, however, very irregular, the crops in the southern district, especially, being frequently liable to excessive moisture and floods.

The Márkanda is the second largest stream in the district, and enters the Pipli Tahsil near Sháhabad, passing through in a south-westerly direction. In the rainy season it is extremely liable to floods, the water spreading over the face of the country far and wide and depositing silt and sand in all directions.

The Jumna on the east and the Sutlej on the north-west also flood a large extent of country near their course, and some damage is done by the water-logging of the soil through the low banks of the Western Jumna Canal.

The climate of Ambala is fairly good, but the changes of temperature are severe. During the rains the country becomes saturated, and fever is common everywhere, the mortality from this cause in years of excessive floods being very high indeed. The cold weather comes on suddenly in November or December before the people have recovered their strength after an epidemic of fever, and the result is much further loss of life from pneumonia. The southern half of the Pípli Tahsil is a specially unhealthy tract, as much land there remains under water for a long time in years of excessive rainfall, owing to the formation of the country and the way in which it is traversed by petty channels which cannot carry off the drainage poured into them.

Pipli Tahsil.—During the rains of 1894 Surra made its appearance, and at the village of Looki four horses and eight asses died. During the wet season of 1895 the returns made included 15 villages, in one of which, Bhoosthala, all the solipeds succumbed to the above disease. As far as could be ascertained, the tahsils Kharar and Naraingarh are freer from Surra than the southern part of Pipli, which is swampy and subject to flooding during the monsoon.

This portion of the district, which is swampy and subject to inundation during the rainy season is a well known centre of Surra. Surra broke out in the village of 'Radour' in November 1895, but the losses were not heavy. Again in 1896 'Chibha' suffered somewhat from the same disease.

In 1895 Surra occurred in 21 villages in this district, which lie, for the most part, between the Western Jumna Canal and the Jumna River. The tract is seriously water-logged and swampy 'Khadir' owing to percolation from the canal. Gogpur and Salpani Kalan are on the banks of the Márkanda, and are subject to inundation in the rains. Omree is on the grand trunk road and is subject to inundation from a small branch of the Ghittang river. The losses have been serious in all, but some of the villages have been practically cleared out of soliped animals.

Jagadhari Tahsil.—Surra made its appearance in October 1894 in the low-lying village of Aurangabad, and out of 17 asses, 13 or 76 per cent. were lost. Although some horses were owned by the villagers, none succumbed to the disease. In the following year the animals in the village of 'Galni,' also subject to inundation, were attacked: 80 per cent. of the horses, cent. per cent. of the asses and mules died from this malady.

Umballa Tahsil.—In the 'Dhin' *gaon*, said to be free from inundation, the disease broke out in the months of November and December 1895, and carried off 20 per cent. of the asses owned.

Umballa, 1896.—By order of the Deputy Commissioner two camels belonging to the Police, and suffering from Surra, were destroyed.

Vernacular name of disease 'Phenta', 'Phera.'

Remarks of Veterinary-Captain Pease in his Annual Report for 1895-96.

"As might be expected from the fact that the lower part of the Umballa District resembles the Nali of Karnal very closely in some parts and the Khadir in others, we find Surra is very common and fatal in the villages which are situated in these parts. The whole of the lower part of the district is dangerous, especially the strip of country which runs across from Thanesar to the Jumna. I should think that the northern limit of the very dangerous tract is about a line drawn from Thaska to Lokhi.

Cases may, however, occur higher up, but from my enquiries I should say that they are not very common. There is a very considerable difference in the conditions in the upper part of the district, although it is all more or less subject to inundation and flooding in the rainy season. The soil is, however, lighter and the river beds sandy, whilst also the water runs very fast in them. The worst part of the country here appears to be between the Jumna Canal and the river in the south-east corner, where, owing to the increase in the amount of water passing through the canal, the whole of the villages in the vicinity are badly water-logged and very unhealthy. Almost every village in this line was attacked last year and the losses were very severe. The continuation of this line in Karnal is also very bad indeed, as has been already mentioned. I do not think that this tract is at all likely to improve as the evil seems to be a growing one, and it is not worth while to bother about horses in these villages. It is quite possible that the disease will increase in the Karnal Depôt as it appears to have done in the villages in the neighbourhood; however time will show."

Ludhiana District.

Ludhiana is the most western of the three districts of the Umballa Division, and has for its northern boundary the river Sutlej for a distance of nearly 60 miles. It comprises an area of 1,375 acres, and has a population of 618,835 souls.

The district is divided into three tahsils—Samrála to the east, Jagraon to the west, and Ludhiana in the middle.

The height above sea level varies from 764 to 870 feet. The district is divided physically into the 'Bet,' a low-lying alluvial tract along the river Sutlej, and the Dhaia, or uplands. This river has always a considerable volume of water, but when in flood it spreads over the country to a width generally of two or three miles. The Budha Nála, a perennial stream, rising in the Rupar Tahsil of Umballa, also becomes swollen by floods in the rains, and covers the country about, and there is generally a good deal of swamp near it.

In the Samrala Tahsil much of injury is done by the spread of swamp, the stream being only slightly below the level of the country, and all land within a short distance is injuriously affected by percolation.

The '*Bet*' is liable annually to inundation, but the floods do not last very long, as they are caused by the rainfall in the plains only. Saline efflorescence appears here and there, owing to the impeded underground drainage, by which the soil is so impregnated that it becomes barren.

The Dhaia, or upland part of the district, stretches to the south in a plain, the uniformity of which is unbroken by hill or stream. The lines of drainage (raos) slope from north-east to south-west, and although in years of heavy rainfall they carry a large volume of water, there is never anything approaching to swamp.

The mean rainfall for the three tahsils for a period of 18 years is—Samrala 27″, Ludhiána 27″, and Jagraon 21″. The monsoon generally begins in the last 10 days of June, and closes at the end of September, with a slight fall in October, and a fairly heavy fall at the end of December, and again in March.

The moist Bet tract is very unhealthy, and during the months of August to November fever is very prevalent. The severity of these attacks varies, but the general result is a weakening of the constitution which makes the people less able to resist the effects of other ailments, and in severe years the mortality is excessive. Amongst cattle anthrax fever or malignant sore throat and foot-and-mouth disease are said to be common. The former is very deadly and most infectious, attacking buffaloes and bullocks alike, but the latter is never very deadly, although the cattle affected are rendered useless for a long time.

Few horses are kept, but camels are used for carrying purposes by the people of most of the jungle villages, where carts cannot work. Sheep and goats are kept in every village, and some donkey and mules for the use of the Kumbhárs or brick-makers.

In 1894 Surra locally known as Zaharbad occurred in four villages in this district. These villages are situated in the 'Bet', a very unhealthy portion of the district, low-lying and alluvial, subject to inundation from the river Sutlej and the Badha Nála.

Jagraon Tahsil.—In 1895 and 1896 Surra outbreaks occurred in fifteen villages in this tahsil. These villages are situated in a low-lying and alluvial portion of the district, which is subject to inundation.

During July-August 1896 Surra made its appearance in three villages of the tahsil, where ten asses and eighteen camels, 35 per cent., succumbed to it.

In the same tahsil the disease appeared in two villages during January, February and July 1897, when 9 camels (36 per cent.) and 30 asses succumbed.

"In the village of Aliwal the people described the symptoms as "having gone weak in the loins". In the latter stages they seem to be able to recognise the disease. The death-rate was 100 per cent.

The people try no remedy now. They used to apply a hot iron across the loins, but when the disease is recognised, they know that there is no hope for the animal, and so resort to charms or leave the case to chance ".—(Veterinary-Captain Gunn).

Jalandhar District.

This lies farthest sout-west of the three districts of the Jálandhar Division. Together with the Native State of Kapúrthala, it occupies the apex of the Doáb, between the Biás and the Sutlej, the Kapurthala territory lying to the westwards and separating the district completely from the Biás river.

The district is divided into four tahsíls, Jálandhar comprising the northern portion of the district, and Nawáshahr, Phillour, and Nakodar, the southern, lying in that order from east to west. It comprises an area of 1,322 square miles, with a population of 789,555.

The height above sea level ranges from 800′ to 1,000′. The sub-montane portion of the Doáb belongs to the Hoshiarpur District. Below the hills the whole is one expanse of alluvial soil, of unvarying fertility throughout. The highest portion is at Rahon, near the eastern corner of the district, where it attains an elevation of 1,012 feet above the sea; from here it gradually slopes westward towards the Biás.

The bed of the Sutlej is marked on the Jálandhar side by a well defined bank, below which there stretches a tract of varying width called " Bet or Khadar " partially submerged during the height of the summer floods. This tract is on an average about 25′ below the rest of the district, the higher land being turned bángar or dhá.

The Jálandhar Doáb receives the drainage of the Siwálik line of hills which traverse its base. The drainage lines unite in two streams, called respectively the east or *sufed* (white) ben, and the west, or *siyah* (black) ben. The former runs through the whole length of the Jálandhar District, the latter almost entirely through Kapúrthala territory. Irrigation from the *sufed* (east) ben is practised by means of Persian wheels upon the banks, which are too high for direct irrigation by overflow of the water.

There are several Jhíls or marshy lakes in the district, which collect a considerable volume of surface drainage in the rains, and retain a certain amount of water throughout the year.

The rainfall in four years varied from 22·8″ to 39″, the average for the four stations for eighteen years being—Jálandhar 31·2″, Phillour 27·1″, Nawashahr 29·4″, and Nakodar 27·5″.

Cattle, sheep, and goats are kept in considerable numbers, donkeys to a less extent, and few horses and camels.

Jalandhar Tahsil—In 1893-94 a village of this tahsíl lost cent. per cent. horses from Surra.

In 1894-95 the names of ten villages are specified in this tahsíl and Surra broke out in three other villages at the commencement of 1896.

At Jalandhar in 1894 two mares from Bhagpur affected with disease were brought for treatment and kept with other horses belonging to Lala Salig Ram. In fifteen days afterwards all the horses were attacked, and as it was feared that the disease would spread, the whole of them were destroyed.

Nawashahar Tahsil—During July and August 1895, Surra broke out in two villages of this tahsíl, 8 horses and 20 asses died out of 21 and 27, animals, respectively.

The disease is reported from two villages of this tahsíl during November 18 96. The loss was 11 horses and 7 asses out of 14 and 32 animals or equal to 78 per cent. and 22 per cent., respectively.

The disease is said to have been very severe in this district in 1895-96. The people say that it spread from them to the ' Bet ' villages.

The vernacular names of the disease in this district appear to be " Táp ", " Sokhra ", " Zaharbad " and " Táp-dik ".

Hoshiarpur District.

The Hoshiarpur District comprises so much of the Siwalik range as lies between the rivers Sutlej and Biás, together with a broad strip of the plain country at the foot of the range, and the greater portion of the valley that lies between it and the outer Himalayas. The Biás and Sutlej rivers practically form the northern and southern boundaries of the district. The area is 2,180 square miles, with a population of 901,381 souls.

The district is divided into four tahsils, *viz.*, Hoshiarpur, Garhshankar, Dasuah, and Una.

The average height above sea level ranges from 920′ to 1,400′.

The district is nearly equally divided into hill and plain. The hills comprise the Siwalik range which runs down the centre of the district and the western slopes of the outer range of the Kángra hills, the two enclosing a valley called " Jaswan Dun." The plains to the west of the Siwalik range are intersected by a number of sandy torrents, the waters of which eventually flow into the Sutlej and Biás.

Along these two rivers are strips of rich alluvial land, composed of sand and loam, over which the waters spread when in flood. Between the town of Dasuah and the Biás there extends a long tract of marsh land, known by the name of "Chhamb," and which is the most unhealthy part of the district. The flooding of the Chhamb commences in June or July and the land remains under water until September, after which it gradually dries up.

The plain portion of the district is of alluvial formation throughout, and was formed from the deposit of silt carried by the hill torrents or *chohs*, which pour down into the plain in the rainy season at almost every mile.

There are a few small canals in the north of the district, taking their rise in the Biás, some of which are liable to flooding the surrounding country in the rains.

The average rainfall of each tahsil is Hoshiarpur 36″, Garshankar 32″, Dasuah 35″, and Una 37″.

The climate of the district is generally healthy, the soil is sandy, and the water has no tendency to collect or stagnate, except in the Chhamb District in Dasuah, where the health of the population is not so good.

The commonest forms of illness are fevers of different kinds, and bowel complaints. Goitre is commonly met with in the hilly tracts, and in the northern plain of Dasuah, where there is much canal irrigation.

Cattle, sheep and goats are kept by the villagers, but few horses, camels, or donkeys.

Dasuah Tahsil.—In 1894-95 Surra was reported to have been very severe and widespread in this tahsil, causing a great loss. It is said, however, that the disease appeared in nearly every village in the tahsil. Twenty villages are specified as having lost the majority of their animals, and in one, Sosgán, 36 horses succumbed to "Surra."

This year the same tahsil is reported to have lost seven horses and five asses out of thirteen horses and seven asses owned by the villagers.

By the natives it is named "Táp," "Sokra", "Zaharbad" and "Táp-dik."

Garshankar Tahsil.—Surra, vernacular name "Wabai-ki-bokhar," is reported to have occurred in three villages during 1894-95. The position of the affected villages is described as low-lying and subject to flooding. Out of 74 horses and 50 asses, 61 and 32 animals equal to 82 per cent. and 64 per cent. succumbed to the disease.

Kangra District.

This vast tract comprising an area of 9,000 square miles, with a population of 730,845 souls, stretched eastwards from the plain country of the Bári and Jalandhar Doábs over the Himalayan ranges and far in Tibet. It is divided into four tahsils, viz., Kángra, Nurpur, Hamirpur and Dera, of which the latter three lie along the south-western border of the district where it adjoins the plains and the Siwaliks, coming in that order from east to west, and lying together with the Kángra Valley among or below the outer Himalayas. The Kángra Tahsil occupies the centre of the district, and connects by a narrow neck known as Bangáhal the three tahsils above mentioned with the outlying tract that forms the Kulu Tahsil or Sub-division.

The district forms two almost separate blocks, which lie one to the west, the other to the east of the outer Himalayan range, which in this direction bounds the horizon of view from the Punjab plains, and are almost separated from each other by the Chamba and Mandi States. The western block, which constitutes Kangra proper, is an irregular triangle, having its base towards Hoshiarpur, and tapering to an angle between the Native States of Mandi on the east and Chamba on the north

The three parallel lines of mountain in the district with the transverse ranges form four basins in which four great rivers take their rise—Biás, the Spiti, the Chenab and the Ravi. The Biás enters Kangra proper and receives the drainage of Kangra valley.

The rainfall varies remarkably in different parts of the district. The average annual fall exceeds 70 inches; along the side of the Dhaola Dhár it amounts to over 100″; while ten miles off it falls to about 70″, and in the southern parts to about 50″.

The endemic diseases of this district are fevers (intermittent and remittent).

There are few horses in the district, and not very many mules. The Government system of mule-breeding has been in operation in this district for the last ten years.

During February 1896 one village is reported to have suffered from "Surra;" the loss recorded was only one horse out of seven owned by the villagers.

Ferozepore District.

The Ferozepore District, embracing an area of 4,076 square miles and a population of 746,176 souls, is divided into five tahsils, of which Mukatsar and Fazilka lie below the Faridkot State, and Zira,

Ferozepore, and Moga lie above it. Moga lies entirely away from the river; Zira occupies the angle opposite the Biás confluence, followed by Ferozepur, which extends down to the point where the district is narrowest; while Mukatsar and Fázilka have limited river frontages but great depths towards the interior.

The surface of the district slopes very gently from the north-east towards the south-west at the rate of about 1½ feet in the mile. It is all of an alluvial formation and contains no hills, and indeed not a rock or stone. On closer acquaintance it is found to be divided into three broad plateaux raised slightly one above the other, the edges of which, in the form of two broken and shelving banks, run nearly parallel to the course of the river. The highest of these three tracts contains nearly all the Moga Tahsil, a few villages in the south of Zira, the extreme south-east corner of Ferozepur and about half of the Mukatsar and Fazilka tahsils. It might be conveniently distinguished as the Kot-Kapura plateau, the pargana so named (now in Faridkot territory) being near its centre and forming a link between the Moga and Mukatsar portions. Its surface is extremely smooth. The soil is rather sandy loam of reddish-brown colour, broken only by the lines of old water-courses, along which sand-drifts are always to be found. The plain comprising the southern half of the Zira Tahsil (excepting a few villages above mentioned), the eastern half of the Ferozepur Tahsil, and all the north-west of Mukatsar and Fazilka, except a strip along the present course of the river, might be called the Mudki plain, from the name of the well-known town and battle-field, which is situated midway in its length. A leading characteristic of this tract is the brackishness of the wells, which increases towards the south-west until the water is undrinkable.

Below the Mudki plain is the river side tract, sometimes called the Bet. Between Zira and the confluence of the Sutlej and Biás the Bet has a width of 12 miles, elsewhere it is not generally more than about 6 miles wide. Its soil is a dark-grey clay intermixed with strata of sand.

The rainfall is very uncertain, the rainy season sometimes beginning in the end of June and sometimes being delayed until the end of July, and the period of its termination is equally uncertain. Ferozepur is proverbial for dust-storms. The average rainfall at Tahsil stations from 1873-74 to 1888-89, was: Ferozepur 22·3, Zira 25·1, Moga 20·9, Mukatsar 13·7, Fazilka 12·3 inches.

No systematic thermometrical record has ever been maintained in the district. Private observations, however, show that in December and January the temperature ranges in houses between 40° and 70°, whilst during June and July (with closed doors) its range in houses not artificially cooled is from 92° to 97°.

There are two distinct varieties of horses bred in the district—the one small but very wiry, bred principally by the Dogars of the Bet; the latter, bred inland, of considerable size, mares being occasionally found of 15-2 in height. The breed of cattle along the river bank and in the Bet generally is inferior; but that in the highlands of the district is very fine.

Owing to dryness of its climate, Ferozepur has acquired the name of being exceptionally healthy, and this reputation is still deserved as regards the City and Cantonment, and also as regards all the upland plains. But in the irrigated lands of the Bet, and also in the towns of the Zira Tahsil standing on the lower bank between the Bet and the sandy country, fever is terribly prevalent in the months of September, October and November. In Zira, current business is often stopped, neither suitors being able to attend the offices, nor the officials able to hear them.

Twenty villages are recorded as having been the seats of Surra outbreaks during the years 1890 to 1896. The loss sustained was 155 horses, 113 asses and 1 mule, which were distributed amongst the three tahsils as follows:—

Fazilka Tahsil.—Two low-lying villages affected with Surra, during May 1890, lost a few animals.

"Surra is recognised in camels by the name of 'Tebersa' or 'three years.' The idea is that the camel may suffer from 'Surra' for years, and that, if an infected animal survives three years, he will be out of danger; hence the name of Tebersa".

"The Ziládár is acquainted with this disease, and a few years ago his village lost several horses; but recently the owners of horses have taken the precaution not to allow their horses to graze in the fields, which are usually rendered swampy by the overflow of the river. Since having adopted this course, there have been no losses from Surra".—(Veterinary-Captain Gunn).

Ferozepur Tahsil.—During 1892, 1893 and 1894 three villages of this tahsil are reported to have suffered from Surra. Out of 27 horses and 57 asses, 8 horses and 4 asses succumbed to the disease.

Surra occurred in seventeen villages of this tahsil during the years 1893—1896; most of the affected part was low-lying.

"Surra seems to be well known, and is reported to have been present in the villages of Naipur, Daryapur, Mokewala, and the villages on the banks of the river to the north of Ferozepur".—(Veterinary-Captain Gunn).

Mukatsar Tahsil.—One outbreak at 'Mokamarain' continued, according to the report submitted, during the months May to August 1895. Eight horses succumbed to the disease "Phenta."

Vernacular names being—'Andartáp', 'Tap', 'Sokra', 'Phenta', 'Marri', 'Soka,' 'Tápedik.'

Amritsar District.

This district comprises 1,558 square miles and is a section of the tract known as the Bári Doáb, or country lying between the Ravi and Biás rivers. It is bounded on the north-west by the Ravi, and on the south-east by the Biás. It is divided into three tahsils, Amritsar, Tarn Taran, and Ajnala, the last named occupying all that portion which fronts the Ravi, and the two former abutting on the Biás. The district is small, compact, and thickly populated, the total population in 1891 being 992,697. It has the appearance of a continuous level plain, unbroken by hill or valley, and sparsely wooded, except near villages and irrigation wells and canals. The formation is distinctly alluvial, and the prevailing soil is a light reddish yellow loam (*Maira*), which stiffens into rohi or clay, where the surface drainage collects on its way down the Doáb from the hills.

In Amritsar, the usual depth of the water from the surface is 30 to 40 feet, except in the high-lands on the banks of the Biás, where it is from 40 to even 60 feet. In Taran Tarn the depth is ordinarily from 40 to 60 feet, except in the "Bet", where it comes to within 12 or 13 feet of the surface. In the Ajnala Tahsil the ordinary depth is from 20 to 30 feet, but under 20 feet in the 'Sailab' and Sakki lands.

The Biás river takes its rise in the Kulu valley, and passsing through the Kangra District enters the sandy valley, which divides the Amritsar District from Kapurthala. On the right the Biás valley is bounded by an abrupt cliff of from 24 to 30 feet. At the foot of this, between it and the cold weather bed of the river, lies a strip of alluvial land "Bet", which, at some points, is as much as two miles broad. The left bank, on the other hand, is uniformly low, and on the Kapurthala side there is a stretch of moist alluvial land running back for several miles into the interior, which is fertile, well wooded, and liable to inundation. The river itself carries an immense body of water in the rainy season, and in flood time is often a mile in width.

The Ravi is a river of different character. Both banks are, for the most part, of equal height, and the river in flood time encroaches impartially on either side.

The Sakki Nála is the only other perennial stream found in the district, and this winds in a deep tortuous bed between abrupt banks, and damage from floods is slight.

There are other minor drainage lines forming quite a net-work in the southern part of Ajnala, and these often take the shape of a chain of swamps or *chhambs*, the principal of which are found at Bhalapind, Bagga, and Jastarwal.

The rainfall is fairly certain, an annual fall of about 20 inches may be expected in that half of the district which is nearest Lahore, and one of about 25 inches in the northern half nearest the hills.

The Amritsar District is not a very healthy one, owing to the net-work of canals and distributaries made in the Tarn Taran Tahsil. Fever is often terribly prevalent throughout the district in the autumn months, when a hot sun in the day succeeds cold and heavy dews at night. The enfeebled and poorly clad victims of malarial fever succumb easily to pneumonia and dysentery in winter.

Cattle are largely kept, and buffaloes are almost a speciality in the district. Horses and ponies too are numerous. Sheep and goats are kept by village menials, chiefly Barais, and mules and donkeys are largely used in the carrying trade as pack animals. Camels are few, as there is little suitable grazing ground for them, and these are solely used as beasts of burden.

Ajnala Tahsil.—Three villages of this tahsil suffered very heavy losses from Surra during the months August—November 1894. The actual number which succumbed were 92 per cent. horses, 40 per cent. asses and 100 per cent. mules possessed by the villagers.

During the rains of 1895 Surra occurred in three villages of this tahsil, one of them, Jastarwal, losing 15 horses. These villages are said to be low-lying and subject to inundation. Surra is often named "Gum Zahrbad."

Amritsar Tahsil—Two villages of this tahsil are reported to have lost 50 per cent. horses and 25 per cent. asses owned, during August and September 1894.

During the months of August and September 1895 the disease appeared in three villages of the above tahsil, to which 77 per cent. horses and 46 per cent. asses of the villages succumbed.

Veterinary-Captain Gunn, in his Annual Report for 1896-97, remarks as follows :—

"At Shamnagar, a village about three miles south of Tirpai, no less than 26 horses out of 28 died during the rainy season of 1895. This part of the country is very low-lying, and in the wet season is really water-logged."

"Surra, locally known as 'Sokra,' would seem to be well known in the neighbourhood of Amritsar, and in proportion to the number of equines is very destructive. At Wala, out of 10 horses and 100 donkeys, 4 of the former and 25 of the latter died in 1895."

"The disease attacked fatally animals in the villages of Fategarh, Sakarchak and Tungpain. In the latter place, out of 7 horses and 22 donkeys, no less than 3 horses and 12 donkeys are reported to have succumbed in August 1895. All this part of the country is low-lying, and the zamindars say that

the disease is caused by the animals eating a species of grass called *Naree*, which grows abundantly in low-lying and water-logged land. They state, with probably little truth, that this grass has only recently appeared in the neighbourhood. In all likelihood the knowledge of the disease has only recently been acquired, and this grass is supposed to be the cause of it."

"It also appeared among the solipeds at Chakmakund, and out of 12 horses, 2 mules and 25 donkeys, 7 horses, 2 mules and 11 donkeys succumbed to the disease."

"The villages Jagatpur, Serai Amantkhan and Kotesayan also suffered from the disease in 1895."

Lahore District.

The total area of the district is 3,602 square miles and has a population of 1,075,379 souls. Of this area about one-fourth lies on the right bank of the Ravi, forming part of what is known as the Rechna Doáb between the Ravi and Chenáb rivers; the remainder is on the left bank, or near side of the Ravi between it and the Sutlej. The Rechna Doáb or Trans-Ravi tract is mostly lowland that has in times past been under the influence of river water.

There are four tahsils in this district, *viz.* Lahore, Kasur, Chunian and Sharakpur.

The surface of the district is in the main level throughout. The valleys of the three rivers, Biás-Ravi and Degh and the ridges between them constitute the principal physical features of the district. The broad and high upland between the Sutlej and Ravi is fairly cultivated towards the north, but contracting towards the south, and as it contracts, assuming the appearance of a barren steppe covered with low bushes giving forage to camels and in favourable seasons, with long grass used as pasturage for cattle. This tract is the celebrated *Munjha*.

The lowlands which lie to the south of *Munjha* are known as the Hithár, derived from the vernacular term *het* (below). The high bank which runs nearly due east and west from the Sutlej, forms the southern boundary of the *Munjha*.

The district is wanting in fertility, except on the banks of rivers and in the canal tracts, but it appears that water is of the greatest necessity.

The average rainfall from 1868 to 1892 was as follows in each tahsil :—

Lahore	...	...	...	...	...	18·2 inches.
Chunian	...	...	...	...	...	18·4 „
Kasur	...	...	...	...	...	19·3 „
Sharakpur	...	...	...	...	...	16·1 „

That for the whole district varies from 20 inches on the north-east border to 8 inches on the south-west and a large proportion of this rain falls in the cold season rather than in the periodical rains during July and August.

The temperature is very variable, from burning hot winds during May and June to an intense cold in December, January and February.

The most common diseases are those which occur in all malarial countries, and the most sickly months of the year in this district are September, October and November.

Cattle Diseases.—Large number of cattle die in this district every year from disease, especially in Sharakpur Tahsil and in the lowlands of Chunian Tahsil. The most common forms of disease are rinderpest called by the natives *mátra* or *pir*; *Mukhor* or foot-and-mouth disease, which of late years has been very prevalent in the Chunián Hithár; *Gal ghotu* or anthrax; *Sokar*, a disease brought on by eating *jowár* stalks that have dried up for want of rain; *Aphára* or swelling of the stomach, which according to the natives is caused by the cattle eating a worm which sometimes breeds in the grass known as *Senji*. Cattle are constantly dying in Sharakpur from inflammation of the bowels, which the natives generally say is brought on by the cattle taking to the hard *jowár* stalks after they have got used to the soft rice straw of which the cattle there eat a great deal in the autumn. Others say the complaint is induced by drinking water from the Deg.—(*Gazetteer of the Lahore District, 1893-94, page 182.*)

Lahore Tahsil.—During December 1894 and January 1895 a loss of 24 horses and 22 asses has been recorded in the three low-lying villages of this tahsil. Veterinary-Captain Pease informs me that Surra is by no means uncommon in the Lahore District along the low-lying portions of land bordering the rivers Ravi and Deg, where it is known as "Zaharbad". All the limbs swell and the usual symptoms are present. Five cases were taken for treatment to the Veterinary College during the 1896 'Surra' season.

Chunian Tahsil.—A low-lying village of this tahsil lost twelve horses in March 1895. The disease is known by the name of 'Sokrá.'

During October and November 1895 two villages of this tahsil are reported to have lost 14 horses out of 21 possessed.

In the month of October 1896 one village of the tahsil lost 4 horses out of 7 owned by the villagers.

During the month of January 1897 the disease is reported to have broken out in a village, causing only a slight loss.

Kasur Tahsil.—During 1894, 1895, and 1896 outbreaks of Surra are recorded in three villages of this tahsil, causing only a slight loss.

Sharakpur Tahsil.—In 1896 ten villages are reported to have suffered from Surra, sustaining a loss of 18 horses and 53 asses, out of 45 and 115 animals respectively. During February 1897 one village suffered a loss of four out of fifteen asses.

Gurdaspur District.

This embraces an area of 1,822 square miles, with a population of 943,922 souls, and comprises the submontane and upper plain portions of the Bári Doáb lying between the Biás and Ravi, and extending across the latter river embraces the eastern submontane of the Rachna Doáb between the Ravi and Chenab. It is divided into four tahsils, Palhánkot, Shakárgarh, Gurdáspur and Batála. The principal places in the district vary from 900 to 1,100 feet above sea level, excluding Dalhousie in the Himalayas at an elevation of 6,740 feet.

The district may be broadly divided into three zones, the hills, the submontane tract, and the plains, the last including the *bangar* or central plateau and the lowlands of the Biás and Ravi valleys.

The chief rivers are the Biás, Ravi, Ujh, Boin and Basantar with numerous smaller drainage lines of the Bangar.

The Ujh valley is about 4 miles wide with a soil of stiff red clay, in which the water is close to the surface and wells can easily be worked.

The Bet or Khádir tract along t e banks of the Biás is much exposed to inundation from the river and intimately connected with the latter is the Káhnúwán *Chambh* or swamp which runs almost the whole length of the Gurdáspur Tahsil.

The Ravi river is also liable to floods in the rains, which spread erratically over the country.

The canals are the Badshahi Nahr, Bári Doáb and Hasli.

The following are approximate statistics of the area irrigated by percolation and by overflow of the river (Ravi), and by canals taking from it :—

	Acres.
Pathánkot Tahsil	30,960
Gurdáspur „	31,701
Shakargarh „	25 858
Bhatála „	16,491
Total ...	105,010

There are several other large and important *chambhs* or swampy lakes in this district, besides the Káhámvan Chambh previously mentioned, which is largely due to percolation from the Biás.

The average rainfall of the district excluding Dalhousie is 37·6 inches, Balála being 30″, Shakargarh 39·3″, and Pathánkot 48·9 inches.

With its heavy rainfall, and a large proportion of its soil saturated with canal irrigation, the climate of the tahsil is naturally moist and unhealthy.

Spleen diseases and goitre are very prevalent, and fever rages during the autumn months. Excessive irrigation and defective drainage and polluted water-supply from filthy village tanks are believed to be the cause of most of the sickness in the district.

Large numbers of cattle, sheep and goats are kept, but comparatively few horses and donkeys, and hardly any camels.

Pathánkot Tahsil.—Between the months of October and December 1895 five villages of this tahsil* are reported to have suffered from Surra and the position of the affected villages is described as low-lying and subject to flooding.

During 1896-97 Surra appeared in this tahsil, but the losses recorded were very small.

Shakargarh Tahsil.—During 1896-97 Surra is reported from this tahsil recording very small losses.

Vernacular names.—" Khusk Zaharbad " and " Sokra ".

Gujranwala District.

The Gujranwala District, comprising an area of 2,906 square miles and a population of 690,169 souls, is divided into four tahsils—Gujranwala lying to the north-east, Wazirabad to the north-west, Hafizabad to the south-west and Khángah-Dogran to the south-east of the district. With the exception of the Chenáb lowlands, along the north-west boundary sloping towards the river and the Deg valley on the south-east, the rest of the district consists of an alluvial plain slightly elevated (800 feet), and of almost unbroken evenness, declining imperceptibly towards the south-west. The country passes through the various gradations by which the soil of the favoured sub-

* (With seven other villages of the district.)

montane region merges into a waterless, almost rain-less, and therefore sterile plain, unculturable save by irrigation. The southern half of the district and a small portion of the west-central portion are supplied with water for irrigation purposes by a canal, which branches from the river Chenáb at Khanki in the Wazirabad Tahsil, but wells are the mainstay of the agriculture of the district. The average rainfall from 1873 to 1892 was about 22 inches. The district enjoys a healthy reputation, notwithstanding the fact that the variation of temperature is very great, *viz.* from a maximum shade temperature of 108° F. in the hot to 29° F. in the cold season.

Very large numbers of bovines and equines as well as sheep and goats are to be found in this district. Camels are also fairly numerous.

Wazirabad Tahsil.—During October and November 1892 the village of Kuka Kolu lost 5 horses and 10 asses. In the year following, during the months of October and November, in the village of Janki-Chatta in the same tahsil, 3 horses and 5 asses succumbed to Surra; vernacular names "Phenta," "Sokra"; neither of these were low-lying.

In 1894 one village of this tahsil suffered from this malady, losing 5 horses and 4 asses.

During 1895, 25 per cent. of the horses and 25 per cent asses died from Surra in five villages of this tahsil. In the same year a low-lying village of the tahsil lost several horses and mules, equivalent to 45 per cent. of the animals possessed.

In 1896 Surra broke out in twenty villages, losing 14 per cent. horses, 18 per cent. asses and 4 per cent mules owned by the villagers.

Gujranwála Tahsil.—Reports have been received concerning the outbreak of Surra in equines during 1894, from nine low-lying villages, and the loss comprised 23 horses and 21 asses.

During 1896 in nineteen villages 63 asses, or 13 per cent. of the animals owned, succumbed to the disease.

Khangah Tahsil.—One low-lying village, Manga, lost 2 asses only in October and November 1895. Disease called 'Pheta'.

During the year 1896 nine low-lying villages suffered loss from Surra. One animal died in March, but all the others succumbed during August, September and October.

Sialkot District.

The general aspect of the district is a plain sloping down from the uplands at the base of the Himalayas to the level country to the south. Bounded on the north-east by the Chenáb and on the south-east by the Ravi, the district is fringed on either side by a line of fresh alluvial soil above which rise the low banks that form the limits of the river beds. At an average distance of 15 miles from the Ravi, another stream, the Degh, which rises in the Jammú hills, traverses this district and passes on into the district of Lahore. This, too, has upon either bank a fringe of low alluvial soil. With the exceptions thus noted, the district is practically a level plain throughout. The district may be divided into six divisions according to the nature of the country: (i) The alluvial lowlands of the Chenáb; (ii) the valley of the Degh; (iii) the alluvial lowlands of the Ravi; (iv) the triangular dorsal plateau west of the Degh; (v) the remainder of the central plateau of the district, between the Degh and the Chenáb; (vi) the dorsal tract between the Ravi and the Degh. The district as a whole is somewhat above the average of the Province in the matter of natural fertility. Three-fourths of its area have been brought under the plough, and except in the large *kallar* plain to the south there is little room for extension of cultivation. The district is watered on two sides of the great rivers of the Province, the Ravi and the Chenáb, which draw their supplies from the snows of the central ranges of the Himalayas. Some of the smaller streams, notably the Bik and the Degh, while destructive in the higher tracts, which slope rapidly to the south, are of the utmost value as fertilizing agents in the southern parts of the district. Numerous marshy depressions known as *Chhambs* occur in many parts, the whole number covering an area of 8,106 acres.

This district embraces an area of 1,963 miles and has a population of 1,119,847 souls. It is divided into five tahsils, Siálkot, Pasrúr, Zafarwál, Ráya and Daska, the northern, west-central, eastern, southern and western portions of the district respectively.

The rainfall of the different tahsils varies from about 24 inches in Raya to 36 in Sialkot.

The district is decidedly healthy on the whole, but the disease is very prevalent in water-logged tracts such as Bagwat and the lower parts of the Degh valley. Malarial fever is the great scourge of the people, and flourishes most in September and October when the people are weakened by the hot weather and cannot stand the great difference between the day and night temperatures. Fever is directly responsible for 68 per cent of the total deaths, but indirectly its fatal effects are more widespread. Many deaths returned as due to pneumonia, dysentery, and other diseases would certainly not have occurred had the patients not been previously debilitated by fever.

Horses and ponies are less numerous than in most districts of the Province. Sheep and goats are kept by the village menials. Donkeys are largely used as pack animals, and are usually kept by the village potters. Camels are not kept to any extent by the people.

Sialkot, Zafarwal and Pasror Tahsils.—Surra occurred during November 1895 in three villages of these tahsils.

It is very possible that the disease is prevalent in parts of this district, but the enquiries which have been so far made are very unsatisfactory.—(Veterinary-Captain Pease).

Jhelum District.

The Jhelum District is one of the four districts of the Ráwalpindi Division and forms the southern half of the rough hill country at the head of the Sind-Ságar Doáb. The superficial area as estimated by the re-measurement made for recent settlement shows an area of 4,039 square miles, with a population of 589,373 souls.

This large tract is divided into four tahsils, *viz.* Jhelum, Pind Dádan Khán, Chakwál and Tallagang. Tahsil Jhelum occupies the whole eastern end. All the west is engrossed by Tahsil Talagang. The central area between is held on the north by Tahsil Chákwál, and on the south by Tahsil Pind Dádan Khan.

Round Jhelum itself there is a wide expanse of level plain which is prolonged into a narrower strip along the course of the river; but elsewhere the surface is generally rough, broken, and disturbed. Much of it is covered by the mountains of the salt range and its tributaries. The whole lower boundary of Tahsil Talagang is fringed by the northern ridges of the hills. Still, in this part of its course, the range keeps mostly to the district of Shahpur; but when it reaches the boundary of Tahsil Pind Dádan Khan it passes altogether into the Jhelum District.

The drainage of the eastern end of the district is by means of the Kahán and Bunha *nuddis* into the Jhelum; that of western by Soj, Gabhir, Ankar and other streams into the Indus. The only river belonging to the district is the Jhelum, which forms the east and a great part of the southern boundary, and skirts the district for rather more than 100 miles. Speaking generally the district cannot be said to be well supplied with water.

The climate of the district is not uniform throughout. The cold of the winter season is sometimes severe and the heat in the summer is very great, specially in valleys and gorges between the hills, where it is sometimes almost suffocating. The following are the average rainfalls of each tahsil:—Jhelum 27·2, Pind Dádan Khan 16·8, Chakwál 14·4, and Talagang 15·1 inches. The district is fairly healthy; malarial fever occurs chiefly along the course of the river, and specially at those parts of it which overflow or change course, thus leaving ground to dry.

The horses of this district, especially those of the Dhan, have long been held in good estimation. Although the Dhan is best known for its horse-breeding, yet very good animals are to be found all over the district. Pack-camels are in pretty extensive use, especially for carrying salt.

Pind Dadan Khan Tahsil.—Surra broke out in two villages of this tahsil during August 1895, causing a slight loss of 6·25 per cent. horses and 6 per cent. asses possessed by the villagers.

In four low-lying villages five animals succumbed to the disease during the months of May, July, August and December 1896. The vernacular name is " Sokra ".

One more outbreak is reported from a village of the same tahsil during October 1896. The loss was not very great.

Peshawar District.

This occupies the extreme north-western corner of the Indian Empire and extends from the Indus to the Khaibar mountains, covering an area of 2,504 square miles, with a population of 599,674 souls.

The Peshawar Valley is an amphitheatre closed in on all sides by hills except for the few miles to the south-east, where it rests upon the Indus. It is drained by the Kabul river, which joins the Indus opposite Attock.

The Peshawar Valley comprises four main natural divisions: 1, a shingly table and fringing the plain immediately below the hills upon the north-west and west; 2, the open plain (*Maira*) of Ysafzai and Hashtnagar; 3, the Doába enclosed between the Sivál and Kabul rivers; 4, a region of low hills and intricate ravines to the south of the Kabul river, gradually rising to the heights of the Khattak hills. To these may be added a fifth division comprising a fertile strip to the south of the Kabul river and the rich lowlands generally, which follow the courses of rivers or lie in the bottom of ravines.

It is divided into 6 tahsils, of which three lie to the east and three to the west of the Sival and Kabul rivers, *viz.* Utmán Bulag, Mardán, and Hashtnagar, and Doába Daudsai, Pesháwar and Nowshera.

The elevation above sea level ranges from 1,108 to 1,200 feet; of the Kabul river, the principal affluents are the Sival, the Bára, and the Kalpani, each having minor affluents.

The country bordering on the Indus is somewhat inundated when the river is at its highest in May, June and July, but the overflow from the Kabul in most places is not extensive, the surplus waters

being conveyed over the adjoining districts by numerous canals and cuts. Below Nowshera the land on either side is, for many months, completely saturated with moisture, the stream in ordinary flood seasons flowing on a level with its banks. Water is therefore everywhere close to the surface, and in parts considerable tracts of bog or marsh are formed, which do not completely dry up at any season of the year.

There are no lakes in the district, but owing to extensive percolation from the rivers, large marshes are formed in many low-lying tracts in the neighbourhood of the Swát and Kábul and a large one exists near Peshawar.

The rainfall varies in the different tahsils, being on an average of four years :—

	Inches.
Utman Bolak	36·7
Mardan (Yusafzai)	23·8
Naushahra	23·2
Doába Dandzai	14·5
Hastnagar	17·3

During May, June and July, the hottest months in the year, the valley is usually most healthy, but in the next three months of hot weather rains, marsh fevers are rife and later inflammatory affections of the lungs and bowels are very prevalent.

Horses are not extensively reared in the district, but large numbers of cattle, sheep and goats are kept and bred. Donkeys and camels are also numerous.

Peshawar Tahsil.—Surra made its appearance in two low-lying villages during the months of September and October 1895. The loss was three horses or 16 per cent. of the animals possessed by the inhabitants of the two villages. Another village lost one of its horses in the month of June of the same year.

During 1896, the disease broke out in two villages comprising a loss of 13 asses out of 72 possessed.

In 1897, a village of this tahsil suffered from the malady, losing one out of eight horses.

Chahársad Tahsil.—In two villages of this tahsil one horse and two asses succumbed to the disease during the month of November 1895.

During 1896, seven horses and seven asses, or 11 per cent. horses and 9 per cent. asses, died of the malady in four villages.

Nowshera Tahsil.—The three low-lying villages of the tahsil suffered a loss of four horses and seventeen asses out of 33 horses and 76 asses during 1896.

In 1897, two villages are reported up to present to have lost 7 asses out of 28 owned by the villagers.

Dera Ismail Khán District.

This district consists of a long block of country stretching from the foot of the Sulimans across the Indus into the *thal* of the Sind Ságar Doáb. It embraces an area of 9,296 square miles and has a population of 441,649 souls.

It is divided into five tahsils. Tank in the north-west, Dera Ismail Khán and Kuláchi, the riverain and sub-montane tracts respectively to the west of the Indus. The cis-Indus area is divided by a line, running roughly east and west into the two tahsils of Bhakkar and Seiah, the former comprising the northern portion.

The height above the sea level of the principal places in the district are :—

Dera Ismail Khán	571 feet.
Kulachi	580 „
Bhakkar	579 „
Seiah	500 „
Tank	600 „
Shekh-Budin	4,513 „

The district is divided by the Indus into cis-Indus and trans-Indus tracts, with areas of 5,542 and 3,754 square miles, respectively.

On the left bank of the Indus there is a broad belt of alluvial land known as the Nasheb or Kachi. This low-lying tract is more or less intersected by streams from the Indus, and the whole is liable to be flooded when the river rises in the rainy season. The high sandy tract to the east of this is called the *thal* and the high plain trans-Indus is known as the Daman. The whole district is hemmed in on the north-west and west by hills but stretches away on the south and east into the great open plain of the Punjab.

The average rainfall in the different tahsils is :—

Dera Ismail Khán	9·0 inches.
Kulachi	7·8 „
Bhakkar	7·5 „
Seiah	7·0 „
Tank	11·0 „

The climate of the district is hot during the summer and cold and bracing during the winter, the frosts at night frequently being so severe as to kill mango and other trees.

On the whole the district is fairly healthy, though there is often a good deal of fever in the autumn and at other seasons after exceptionally heavy rain. This fever sometimes takes a very malignant type, decimating the population in some of the Daman villages.

The number of cattle, sheep, goats and camels kept fluctuates considerably. Most of the buffaloes of the district are to be found in the river villages on the Indus. In good years sheep multiply fast, but occasionally nearly the whole stock of a group of villages is exterminated owing to murrains. There are a good many horses and donkeys in the district, the latter being kept principally by *banyas* for conveying merchandise, &c.

Veterinary-Surgeon G. Evans deals in length with 'Surra' upon his investigations carried on in this district in his report published in 1880. He states that the disease is new to science; it is not new in reality, for it has been only too well known to the natives of Dera Ismail Khán District for several generations as an occasional scourge. He writes: "Major Underwood, 4th Punjab Cavalry, informed me that the 3rd Punjab Cavalry lost 350 horses from *Surra* at Asni near Rajanpore a few years ago."

The percentages of fatal cases among the horses of the 4th Punjab Cavalry at the outposts, with reference to the numbers of horses there during the two past years and the year 1880 up to the end of September, are recorded as follows :—

Years.	Number of cases.
1878	33·3 per cent.
1879	46·8 „
1880	56·4 „

Further, it is stated that the 4th Sikhs have lost the following numbers of camels, during the years 1878—1880; "and with two or three exceptions they are all supposed to have died from Surra" :—

In 1878 there died 29 camels.
„ 1879 „ 41 „
„ 1880 „ 28 „

And there were ten on the sick list for it in October.

The disease is known by several names, such as *Khanhog*, and *Doaia* and *Surra*, depending upon the several stages. *Phipri* is another name by which it is known among camels.

The following in tabular form will show the number of horses that died at different outposts in the district during the years 1878—1880, visited by Veterinary-Surgeon G. Evans in 1880, and described in his report, pages 85—89 :—

Name of outpost.	Number of horses died.			Total.	Remarks.
	1878.	1879.	1880.		
Tank	...	44	30	74	"The tahsildár of Tank informs me
Kot Nusarm ...	13	...	1	14	that a great number of horses (he does
Zam	9	1	...	10	not know how many) belonging to the
Girni	7	4	...	11	zamindars died of *Surra* last year (1879);
Jutta	...	99	47	146	but the disease was not common for
Manghi	15	11	36	62	twenty years previously, when the whole
Luni	...	8	...	8	of the Nawab's horses (about 300) died of
Zarkani	21	...	...	21	*Surra*."
Draband	3	33	...	36	
Total ...	68	200	114	382	

In August 1895 Surra, vernacular name "Sar," occurred in the village of Shah-doad; three horses died out of seven. In the same year nine more villages were affected of the Dera Ismail Khán Tahsil. The disease is well known in some of the low-lying villages.

Multan District.

This district comprises an area of 5,880 square miles, of which more than half is Government waste, the total population being 551,964 souls. It is divided into five tahsils, *viz.*, Multan, Shujabad, Lodhran, Mailsi and Sarai Sidhu; of which that of Sarai Sidhu comprises the Ravi riverain and the

northern portion of the Chenáb low-lands and central plateau ; that of Mailsi the eastern riverain of the Sutlej and the south-eastern part of the plateau ; and that of Lodhran the western riverain of the Sutlej and the angle at the junction of that river with the Chenáb ; while the Multan and Shujabad tahsils, of which the former lies to the north and the latter to the south, include the median low-lands of the Chenáb, the Multan Tahsil also stretching away from the river into the centre of the district.

The whole of this tract is an alluvial plain sloping gently from the north-east to the south-west. It is all of comparatively and much of it of very recent formation. The general aspect of the district is as follows. Starting from the present banks of the rivers Chenáb and Sutlej, we find first of all a strip of land subject to *Sailáb* or the annual overflow of the rivers during the rains. This strip extends inland about three miles on the Sutlej, and rather further on the Chenáb and Ravi. These lands form the low *chaks* or assessment circles of the regular and present settlements ; they are traversed by the canals, but do not generally receive much canal water. Beyond these comes a belt of higher land where wells can be made without difficulty, the water being from 20 to 30 feet below the surface, and on which canal irrigation is generally plentiful. The depth of this belt depends chiefly on the canals. Where there are none, as in most parts of Sarai Sidhu, it is not more than four or five miles ; along the Chenáb, where canals run almost parallel with the river, it is six or seven miles ; and along the Sutlej, where they strike more inland, it is more than ten miles.

Multan is celebrated for its heat, but it is doubtful whether it is really much hotter than most other districts in the plains. The hottest month is June, in which the mean temperature of the air in the shade stands at 95·73° F. and January is the coolest, in which it is registered 54·70° F. The average rainfall from 1873-74 to 1877-78 of each tahsil in tenths of an inch was : Multan 65, Shujabad 41, Lodhran 61, Mailsi 19, Sarai Sidhu 41.

The district is certainly a healthy one. The prevailing sickness is fever, which is very general from August to the end of October. It is very difficult to shake off entirely, but is not often fatal.

Lodhran Tahsil.—During the months of April, May and June 1895, Surra, vernacular name "Sár," is said to have broken out amongst the equines of four villages of this tahsil, when twenty-four horses out of a total of thirty-seven succumbed to the disease, representing 64 per cent. of those possessed by the villagers.

Muzaffargarh District.

The following outbreaks of Surra are reported in this district :—

Muzaffargarh Tahsil.—In the village of Kodewala, Surra appeared during the month of January 1895, a horse and two asses died. During October of the same year a low-lying village Doába suffered from the disease and lost five horses and five asses, out of 40 horses and 50 asses kept.

During 1896, four villages of this tahsil are reported to have suffered from the disease ; the loss sustained was 8 horses and 9 asses only, out of 57 horses and 112 asses owned by the villagers.

Alipur Tahsil.—One village of this tahsil, *viz.* Bastideni, suffered from Surra during October 1895 and lost five horses out of nineteen.

North-Western Provinces.

Saharanpur District.

This is the most northerly district of the Doáb and is bounded on the north-east and east by the Siwálik hills and the Ganges ; on the north-west and west by the Jumna, and on the south by the district of Muzaffarnagar. It comprises an area of 2,219 square miles, with a population of 883,732 souls or 399 to the square mile. It is divided into four tahsils, Saharanpur, Deoband, Roorkee and Nakur. Below the Siwáliks lie the Bhábar and Terai, and in the north-east corner of the district is the great alluvial Khádir land, through which one-half the mountain drainage finds its way to the Ganges. To the east and west are the great basins of the Ganges and Jumna, and southward the Bangar or uplands, itself divided into lowland and upland, marked by the basins and watersheds of the rivers, which flow through it southwards. The Siwalik range is pierced by numerous passes, chief of which are the Mohand, on the Mussoorie road, and the Timli on the road to Chakrata.

The soil in this sub-montane tract is of a dark-chocolate colour, and rests on a stratum of boulders. In the immediate vicinity of the hills the water rises to the surface, and exhibits itself in pools or streams and rills, which flow for a short distance and then disappear in the sand and shingle.

In the belt, Bhabar, varying from five to ten miles in width, water can only be found at depths varying from 100 to 150 feet. This belt consists of a layer of boulders, resting on an impervious bed of indurated gravel and clay, along which the percolation water runs, until the bed again crops up at the surface, to form the southern boundary of the waterless tract and the northern boundary of the Terai or moist tract. Here the streams again appear at the surface, and unite together to form rivers.

The lowlands, on the west of the sub-montane tract, are confined to the old or existing bed of the Jumna.

The surface of the country has a general slope from north to south, and in the north-east of the district this is combined with a slope towards the south-east.

Irrigation is carried on extensively from wells, tanks and canals, two-ninths of the total cultivated area of the district being so watered. Owing to excessive percolation from the canals numerous jhils or swamps were formed, but these by suitable drainage have now been reclaimed. The rains usually set in towards the close of June, and last until the middle of September, or sometimes a month later. Irregularities in their occurrence are surely followed or accompanied by disease, generally in the form of fever. The average total rainfall, according to seasons, for the whole district, varies from 18·9 to 56·6 inches, with a mean for 11 years of 35·7 inches.

The minimum temperature observed by Dr. Royle was 37° in January, the maximum 105° or 107°. The temperature rises rapidly from the beginning of March, and by the middle of June the maximum is attained.

There is no local breed of cattle in the district. The breed of horses in the southern part of the district called the Katha is considered very good, and it was partly on that account that a stud depôt was established at Saharanpur in the year 1842.

Nakur Tahsil.—Statistics were obtained from fifty-three (53) villages in the tahsil, and in three other *gaons*. Surra was known to have been present after the rains (November 1895), *viz.*, Khoona, Childana and Danapur, but no numbers were obtainable.

Later it is reported, in addition, from 22 villages, during the month of January.

Deoband, Roorkee and Saharanpur Tahsils.—Later returns show that in addition to the above mentioned outbreaks, Surra also occurred in eight villages during November and December in the Deoband Tahsil, in six during September and October in the Roorkee, and in nine villages during August to December in the Saharanpur Tahsil.

The animals of ninety-eight villages in all have been reported as having been attacked by Surra.

The Outbreak of Surra on the Saharanpur-Rájpur Dâk Line during the rains of 1894.

1. *Route.*—Between Saharanpur (elevation 900 feet) and Rájpur (elevation 3,320 feet), a distance of 49 miles, there are twelve stages or chowkis for tonga ponies. From Saharanpur to Mohand (elevation 2,255 feet), a distance of 28 miles, the road traverses the plains, the ascent of 1,200 feet being very gradual from Fattehpur. At Mohand the road enters a defile (Mohand Pass) through which the Mohan Rau flows, hills of from 200 to 500 feet elevation rising on either side. The summit of the pass is reached at Asarori (elevation 2,685 feet), 9 or 10 miles from the southern entrance. From this point the road descends, crosses the valley of the Dún to Dehra (elevation 2,232 feet), and finally terminates at Rájpur.

2. *Dâk Contractor.*—The tonga dâk gharries on this route are owned by five or six different contractors, each working separately. Of these one firm only—Smith, Rodwell and Company—are Europeans.

All the tonga ponies, numbering some 373, are registered under the supervision of the Collector of Saharanpur, but of the numerous ekka animals no account at all is kept. Consequently a considerable amount of trouble was experienced in obtaining any reliable data concerning the actual number of animals attacked with disease, and the number and dates of deaths.

3. *Recognition of the disease.*—Enquiries were made amongst the Dâk Proprietors and their servants regarding Surra. The name of the disease is quite unknown to them; they however all agree in describing a disease which makes its appearance within a month or two after the commencement of the rains, and which they simply term "Bukhar" fever, but which shows definite symptoms. This disease attacks horses, principally between Mohand and Asarori, and when once stricken with it, they say, no animal has been known to recover.

4. *History of Outbreak of* 1893.—No records are forthcoming concerning any outbreak of Surra anterior to 1893; but the symptoms of the disease during the present rainy season and the last were recognised as similar to those which the ponies presented in previous epidemics, the years 1880 and 1889 being mentioned.

In 1893 the first death from Surra occurred at the Tunbara Chowki on July 30th; and between this date and the end of the rains 84 ponies are said to have succumbed to this disease, 72 of which cases occurred between Mohand and Asarori; whilst 12 animals died at Fattehpur, the fourth chowki from Saharanpur. One animal was transferred here from the Mohand Pass in June 1893, "because it was looking ill and pulled down." This animal was the first one to show the disease in August of the same year.

It is uncertain whether this animal brought the disease to Fattehpur, and was the direct cause of the other eleven ponies contracting Surra; but evidence of an important nature was communicated to me by an eye-witness. The Chumars at this village, after skinning horses or other animals which have died in the vicinity, wash the skins in the tank. Now if the skin of the first horse was so treated (and when it is understood that the amount of blood in a horse is equivalent to about 1/15 of its body weight,

and that at the time of death one pound of blood frequently contains a minimum of 2,358,629,000 hæmatozoa, and the natural habitat of this protozoon is water), here then is a ready source by which the disease may have been transmitted; and the astonishing point is that more animals did not succumb at this chowki.

It will be seen on reference to Appendix No. III that the average total rainfall in the Mohand Pass during 1893 was 95·88 inches, and from the commencement of the month of May until the first death took place on July 30th, 46·39 inches. This latter average in 1893 is in excess to the extent of 28·27 inches over the average for 1890, 1891, and 1892.

5. *History of outbreak of* 1894.—The first death from Surra took place at Asarori on the 28th July 1894, others following at Lundibara and Tunbara stations in the Pass. Six ponies belonging to Messrs. Smith and Rodwell at Asarori were taken ill on the 15th July and died on the following dates:—

1	died on	August 1st,	1894,	17 days.
1	do.	5th do.	21	do.
1	do.	7th do.	23	do.
3	do.	31st do.	47	do.

On September 24th, 30 ponies were reported to have died of Surra at Asarori, and the same number (30) at Mohand; whilst 6 others were found to be suffering from the disease at the latter station, 2 also at Rajpur, 3 at Dehra Dun, 3 at Bhindal, 1 at Lundibara, 1 at Ganeshpur, and 1 at Saharanpur, making a total of 77 ponies, of which 71 had been posted at stations in the Mohand Pass.

Rainfall.—The average total rainfall in the Mohand Pass during the months January to end of September 1894 was 107·95 inches, and from May to end of July, when the first death occurred (from Surra), was 57·62 inches. This latter average for 1894 is in excess to the extent of (39·5 inches) over the average for the years 1890, 1891 and 1892, and 11·23 inches in excess of the rainfall of 1893.

6. *Water-supply.*—Between Saharanpur and Ganeshpur water is supplied to the animals from *pukka* wells during the greater part of the year; but during the hot season the animals are watered wherever there is any to be found.

At Fattehpur there is a large tank, and the Bhistis take their supply from it. Between Mohand and Lundibara animals are watered at the river side, as there are no wells. During the rains, the river water is brown in colour and laden with mud; sometimes it is so thick that it is necessary to collect it in vessels (*Baltis*) and allow the mud to settle before giving it to the horses. Messrs. Smith and Rodwell, at their chowkis in the Mohand Pass, filter and boil the water before giving it to their tonga animals.

7. *Grass.*—Grass-cutters are employed at each chowki. The grass is obtained from the jungle in the immediate neighbourhood and from the banks of the river in the Pass. This coarse pahari grass, which is that most commonly obtained for animals, grows in tufts about two feet high and is circular in form. It is however grass which has been subjected to inundation, and to which a certain amount of the mud suspended in the water has adhered. To the latter fact is due, no doubt, the somewhat disagreeable odour which it gives off; horses appear to like it, however, and some thrive upon it.

It must be noted that up to the present neither the Surra protozoon nor its resting form has been demonstrated on inundated grass, as Surra does not appear until 1, 2 or 3 months after commencement of the rains; but since protozoa, as a class, have their natural habitat in water and mud, and as the accumulated evidence bearing on this question from India and Burmah lays the onus on the grass, but little room for doubt is left that grass so subjected, when eaten by susceptible animals, is one, if not the most fruitful, cause of the disease.

8. *Corn.*—Gram and bran (*chokar*) is universally given to the Dâk animals.

The corn at the different chowkis is stored in wooden boxes and sacks.

The grain is bought at Saharanpur and is then stored in sacks. The natives in this part of the country store their corn after the harvest in holes excavated beneath the floors of their buildings. These have no pukka walls, and therefore offer no resistance to the incursions of rats or bandicoots should they burrow into them.

9. *Salt, &c.*—Two parts of salt and one part of ajwan are mixed together, and half a chittak of this mixture is given to each horse every third day.

10. *Stables.*—The stables at several stages in the Mohand Pass are literally situated on the extreme edge of the low bank of the river, hills rising on either side. These chowkis are liable to inundation at any time during the rains.

Owing to the mortality from Glanders, Surra, &c., one Dâk contractor has moved his own animals from the chowkis where the greatest mortality occurs and has put up other stables some distance apart. A succession of horses have been kept for years in the same buildings; and although during the above

period different forms of disease have prevailed, in many instances little has been done to eradicate their spores. When death overtakes these animals either in the stables or working on the road, the same thing practically happens. The carcass is simply dragged a few yards from the line of route or perhaps into the immediate jungle, and there becomes a prey of wild beasts and birds. The ground, which has been soiled with the blood and some fluids of the body, probably becomes the seat of the resting form or spores of the disease, which during the next rains again light up and become, if opportunity offers, the means by which other animals eating the grass therefrom receive the contagium into their system. Wild animals, *viz.*, hyenas, jackals, &c., may also be the means of disseminating the virus. On 24th September 1894, I saw a horse lying dead within 5 yards of the road between Mohand and Ganeshpur. In 1893, Smith and Rodwell's Manager shot two hyenas and several jackals which were feeding on the carcass of a horse just dead of Surra.

11. *Mode of communication of disease.*—Several instances presented themselves where both healthy and diseased horses were standing side by side, both classes of animals presented open sores (galls) on their bodies, generally on either side of the spinal column. Crows were perched on their backs, pecking and scratching the sores, and in several instances drawing blood. The birds moved freely from the back of one animal to the other; and no doubt this is one source by which the disease is spread. This would occur with the greatest ease either with their blood-stained beaks or with their soiled feet coming in contact with a raw surface; for I have proved that a minute fraction of a drop of blood containing the Surra hæmatozoon is capable of conveying the disease to the horse if spread over a scratch in the skin of the animal.

Flies.—On the 24th September, at Mohand, I demonstrated microscopically the Surra hæmatozoon in the blood of flies taken from the bodies of horses suffering from the disease, in the blood of which the protozoon was present at the time.

12. *Bovines.*—Although it was definitely stated that cows, buffaloes and bullocks do not suffer from Surra or fever on this route, I took the temperature and examined the blood of one large bullock at Mohand, and found the temperature to be 105° F., and the animal in very poor condition: no hæmatozoa were present, but it might have been during a period of intermission. On enquiry it was ascertained that nine bullocks were attacked and succumbed during August 1894.

TABLE II.

Showing the name of the owner, the stage, and the number of horses, which succumbed to Surra during the year 1893 (rainy season) on the Dák Line between Saharanpur and Rájpur.

Stages.	Smith and Rodwell.	Rukunuddin.	Asgharali.	Shk, Nobi Bux.	Lalta Pershad.	Total number of Horses.
	Number of Horses.	Number of Horses.	Number of Horses.	Number of Horses.	Number of Horses.	
Saharanpur	.....	.....	.....	.....	.....	.....
Kailaspur	.....	.....	.....	.....	.....	.....
Haraura	.....	.....	.....	.....	.....	.....
Fattehpur	5*	.....	.....	.....	6	11
Nuddi	3	... ..	.....	.....	.....	3
Ganeshpore	.....	.....	.....	.....	.....	.....
Mohand	10	8	6	4	11	39
Tunbara	5	1	.....	6	10	22
Lundibara	.....	.....	.....	.....	.....	.....
Asarori	.....	7	.....	.....	.....	7
Bhindal	.....	.....	.....	.....	.....	.....
Dehra Dun	.....	.....	.....	.....	.....	.....
Body Guard	.....	.....	.....	.....	.....	.....
Rajpur...	.....	.....	.....	.....	.....	.....
Total ...	23	16	6	10	27	82

* First pony to show the disease in August 1893. 23 died in August and September. Smith Rodwell lost in 1893, 36 ponies, 23 of Surra. Rukunuddin lost 16 of Surra and several others.

Table III.

Showing the name of owner, the stage, and the number of horses which succumbed to Surra during the rainy season and up to the end of October 1894, on the Dâk Line between Saharanpur and Rajpur.

Stages.	Elevation. Feet.	Number of ponies at commencement of season.	Smith and Rodwell.	Rukunuddin.	Ashgarali.	Shk, Nobi Bux.	Lalta Pershad.	Total.	Remarks.
Saharanpur	900	25	...	...	...	...	1	1	
Kailaspur	...	23	...	...	...	...	...	...	
Haraura	...	28	...	...	...	...	...	...	
Fattehpur	954	29	...	...	...	...	...	...	
Nuddi	...	32	...	...	...	...	...	...	
Ganeshpore	...	31	1	...	...	...	...	1	
Mohand	2,155	28	6	4	4	6	...	20	Stations included in the Mohand Pass
Tunbara	...	17	...	6	6	6	10	28	
Lundibara	2,460	16							
Asarori	2,685	19	*6	...	‡24	...	...	30	
Bhindal	...	29	3	...	...	...	...	3	
Dehra Dun	2,232	32	...	...	3	...	...	3	
Body Guard	...	32	...	...	...	...	...	...	
Rajpur	3,320	32	†2	...	...	...	...	2	
			18	10	13	12	11	88	
				46+24‡=70					

* Smith and Rodwell.—Six ponies taken ill on the 15th July 1894. Deaths occurred—one each on the 1st, 5th and 7th October, and 3 on the 31st October 1894.

† Smith and Rodwell.—Two ponies which were treated and died at Rajpur, one came from Asarori, the other from Nuddi.

‡ Twenty-four horses belonging to Ruknuddin, Ashgarali, Nubi Bux and Lalta Pershad succumbed to Surra at Asarori.

Table IV.

Showing the rainfall and number of Horses that died at the different Stations on the Dâk Line between Saharanpur and Rajpur during the years 1889 to 1897.

Names of Stations.		1889.	1890.	1891.	1892.	1893.	1894 up to the end of September.	1895.	1896.	1897 up to the end of October.	Number of Horses which died of Surra in the following years. 1889 to 1892.	1893.	1894.	1895.	1896.	1897.	Total.	Remarks.
		Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.								
Saharanpur, Elevation 900 feet.	Recorded total rainfall.	45·19	45·77	46·21	38·03	47·49	43·76	59·94	24·40	28·23	No accurate records forthcoming.	a14	1	6	...	b7	28	a Fattehpur and Nuddi. b Nuddi.
	Rainfall in May, June and July.	25·34	29·42	6·85	5·18	16·30	22·23	33·59	10·51	15·77								
Mohand, Elevation 2,155 feet.	Recorded total rainfall.	82·04	65·66	61·62	65·66	91·80	101·33	69·59	58·43	52·43		c61	d49	44	4	d15	173	c Mohand & Tanbara. d Ganeshpur, Mohand and Tanbara.
	Rainfall in May, June and July.	33·53	25·29	6·25	5·21	39·68	51·44	28·32	22·61	19·39								
Asarori, Elevation 2,685 feet.	Recorded total rainfall.	88·43	46·47	54·55	73·28	99·97	114·57	72·06	65·14	65·33		7	30	3	6	...	46	
	Rainfall in May, June and July.	42·41	24·23	12·98	34·81	53·11	63·81	29·12	27·11	30·70								
*DehraDun, Elevation 2,232 feet.	Recorded total rainfall.	109·45	94·56	59·85	75·14	108·99	116·95	81·86	73·93	70·52		...	e6	3	...	4	13	e Bhindal and Dehra Dun.
	Rainfall in May, June and July.	59·49	49·79	20·06	27·82	56·53	64·47	31·12	34·20	26·97								
Rajpur, Elevation 3,320 feet.	Recorded total rainfall.	.....	...	63·31	99·76	157·46	192·21	129·32	95·66	112·94		...	2	...	...	...	2	
	Rainfall in May, June and July.	.....	...	18·30	45·10	83·38	100·29	52·98	44·92	40·68								
										Total deaths. ...		82	88	56	10	26	262	

*Maximum rainfall of 38 years 119·9 inches in 1885.
Minimum rainfall of 38 years 35·1 inches in 1848.

Meerut District.

This is situated in the tract of country known as the Upper Duáb. It is bounded on the north by the Muzaffarnagar District, on the east by the Ganges, on the west by the Jumna and on the south by the Bulandshahr District.

It comprises an area of about 2,353 square miles, with a population of 1,273,914 souls, or 541 to the square mile.

It is divided into 6 tahsíls, *viz.*, Meerut, Hapur, Ghaziabad, Bagpat, Sardhana, and Mawana.

The whole district presents a level alluvial plain, without any hills or even eminences of any magnitude, the elevation ranging from 690 feet in the south to 770 feet in the north. The average rainfall for 9 years was 27·53 inches, but it varies in different years from 17 to 37 inches. There are no usar plains in the district, and the comparative absence of the saline efflorescence '*reh*' is very marked. The Ganges Khádír is very wide and some eight to ten thousand cattle are occasionally grazed on it during the year, but not in the rainy season.

The principal rivers of the district are the Ganges, Jumna and Hindan, and there are three main lines of canals, the eastern Jumna, the main branch of the Ganges, and Anúpshahr branch of the Ganges canal.

The district is not subjected to floods to any great extent and is one of the healthiest in India.

The average rainfall varies from 17·3 to 37·96 inches, with a mean of 26·5 inches, for the years 1844-45 to 1871-72.

Cattle, buffaloes, sheep, goats, horses and donkeys are the domestic animals kept in this district.

The breed of horses has wonderfully improved during the last fifteen years. Several zamindárs have fine horses by Arab stallions out of Katha mares and by the stallions of the Government Hápur Stud out of country-bred mares.

Gaziabad Tahsil.—Surra was prevalent amongst the camels in the village of 'Naoni' in the Gaziabad Tahsil of this district in October and November 1895. This village is situated in the Jumna Khadirs, and although the village itself lies very high the surrounding land is flooded in the rains. There are between 200 and 300 camels in the village, and of these 30 or 40 had died, when the report was made, out of 60 odd attacked. This disease is well known to the people as 'Phitgaya' or 'Purana'. They do what they can to avoid it by driving camels away to the Bangar lands in the rains, and watering those which remain at wells only during the rainy season. They attribute the disease to tank or stagnant water, and do not water their animals at open places until the water has stood for a considerable time and become 'pakka'. They consider that the disease is very contagious. The diagnosis is most surely made by the smell of the urine, which becomes very offensive. There are paroxysms, during which the animals do not feed, and free periods.

The disease often runs its course very slowly, lasting for years. Sick animals are isolated from healthy ones.

Muzaffarnagar District.

This lies immediately south of the Saharanpur District, is bounded on the east and west by the Ganges and the Jumna, and on the south by the Meerut District. It has an area of 1,645 square miles, with a population of 690,107 souls, or 419·5 to the square mile, and is from 760 to 830 feet above sea level.

It is divided into four tahsils, Muzaffarnagar, Shamli, Jansath, and Budhana: and from its physical features may be divided into four tracts, *viz.*:—the valley of the Ganges; the tract between the Ganges and the West Kalinadi, watered by the Ganges canal; the Kali Hindan Duáb; and the tract to the west of the Hindan, bordering upon the Jumna, and partly watered by the eastern Jumna canal.

Along the Solani river from north to south lies an almost continuous swamp fed by the overflow from the river and by percolation from the Ganges canal, which has ruined many villages. In other parts of the district, also, village after village has been injured by increasing marsh formed from percolation from the canal.

The western tract between the Hindan and Jumna rivers is, as a rule, low, and in the rains is often inundated towards Kandhla on the south, and Jhanjhana on the north-west. The district is in places injured by the appearance of *reh* (impure carbonate of soda) due to over-saturation and by the overflow of rivers in the time of flood.

The climate resembles that of Saharanpur, but the rainfall is less, being to the greater distance from the hills. The average heat is decidedly greater than in Saharanpur, though perceptibly less than at Meerut, only half a degree south. The average rainfall for the eleven years 1860-61 to 1870-71 ranges from 15·1 to 39·4 inches.

The chief epidemic cattle diseases of the district are rinderpest (mahámi chera), foot-and-mouth disease (rora, akráo, dephora), and pleuro pneumonia (piphri) which mostly prevail in the district towards the end of the rainy season.

The stud extends its operation to this district, but horse-breeding is not so popular here as in Saharanpur, though some fair animals may be found in the Rájput *chaubisi* in the north-west of the district on the Saharanpur border.

Shamli Tahsil.—During the rains of 1895 sixteen villages are reported in the Kairana Pargana as having been the seats of Surra. Twelve out of sixteen are said to be low-lying and subject to inundation.

Only incomplete reports have been received with regard to the outbreak of Surra which appeared in 1896-97 in three villages in this district. A few animals only succumbed during the last season, owing to the scarcity of rain.

Bulandshahr District.

This is situated between the Ganges and Jumna rivers, south of the Meerut District, and is bounded on the south by the Aligarh District. It embraces an area of 1,906·2 square miles, with a population of 936,593 souls, or 490 to the square mile.

The district is divided into four tahsils, *viz.*, Bulandshahr or Baran, Anúpshahr, Khurja and Sikandarabad.

The general surface of the country is an almost uniform level, with a gradual slope to the south-east of about 18″ in the mile; its height above sea-level ranging from 727 to 636 feet.

The soil is principally a rich loam, but the high banks of the Ganges and Jumna, which divide the bangar or uplands from the Khadir or bed of the river, are poor and sandy. Usar plains are found in almost all the parganas of this district and are quite barren.

The chief rivers are the Jumna, the Ganges, the Hindan and the East Kalinadi.

The Khadir or low alluvial lands are, however, for the most part, confined to one side of the Kalinadi for a distance of several miles, and further on, are to be found extending for some distance, on the other side. The course of this stream is very tortuous, and the turns and bends are very numerous, being in some places almost a succession of loops.

In years of severe rainfall the Jumna is liable to flood and inundate a large tract of country, and the Ganges, at a place called Biborapur, above Ahar, flows over the low-lying country.

Along the Kalinadi some injury is done by the over-saturation of the neighbouring land, and the Hindan is also liable to flood, and deposit silt on the inundated tracts.

The climate varies greatly, being very cold in the winter, when the thermometer frequently falls to or near the freezing point, and hot and moist in the extreme in the rains. The average rainfall is 32 inches, ranging from 17·8 inches to 32·5.

A great improvement has taken place in the breed of horses, since stallions from the Government Stud at Babugarh in pargana Hapur of the Meerut District have been quartered at various places in this district. The Zamindars, almost without exception, take advantage of them, and the result is that strong and handsome colts and fillies are now commonly seen throughout the district.

The bullocks and cows are of ordinary size. The breed of sheep, camels and goats is not worthy of notice, and no attempts at improvement have been made.

Domestic animals kept are the same as in Meerut District.

The great increase in fevers during the last few years has kept pace with the increased activity in the canals and more extended irrigations, and so far the canals have had a prejudicial effect on the public health in this district.

Some thousands of mares, according to Veterinary-Captain Rayment, have died in this district from Surra, during the years 1888 to 1893.

Sikandarabad Tahsil.—Surra occurred in the village of Rahbopura in the Sikandarabad Tahsil of this district in 1892. This village is in the Jumna Khadirs, about four miles distant from the river, and is subject to inundation. It is a Biluch village, and the people used to keep numbers of camels. There were about 400 there in 1892, but the whole of these animals died between the rains of that year and 1894. The following villages, which were inhabited by camel-men have also suffered very severely from the disease:—Thagghar, Tahangerpur, Malerna and Kakur. These villages used to be full of camels, but few remain at present, and many of the people have been ruined from the losses caused by this disease. The country is reported to be water-logged and subject to 'reh'.

Fyzabad District.

Surra occurred in the 3rd Bengal Cavalry stationed at the Fyzabad cantonments, in October, November and December 1893. Fyzabad is low-lying on the banks of the Sarju River, which

inundates the country up to the cavalry lines in the rains. The disease is said to have first appeared in a squadron of horses which were out on duty during the rainy season in the Azamgarh District at Jhajman. The large marshes and lakes that dot the surface of the land are the most prominent objects in the landscape of the Azamgarh District. Many of the horses died, and the disease also appeared in those of the remainder of the regiment. One hundred and fifty (150) horses succumbed to the disease. Surra is said to have also caused considerable loss in 1894. The probable reason the horses which had been out on duty in 1893 were first attacked is, that they were weakened by exposure to the climate in the rains, and so fell victims to the disease earlier than the others.

Kumaon Division.

R. and K. Railway Tonga Service.

Kathgodam.—The North-East Terminus of the R. and K. Railway, and station for Naini Tal, about 66 miles from Bareilly, is situated at an elevation of about 1,600 feet above sea-level, at the foot of the outer Himalayan hills. The rainfall varies considerably in different years from 65 to 160 inches, but until recently, when a water-supply from the hills was laid on, during the hot seasons, a scarcity occasionally was known. A service, with its head-quarters at Kathgodam, supplies tongas for the carriage of passengers to Naini Tal (6,357 feet elevation). Between the Terminus and Naini Tal, a distance of 22 miles, six stages are situated, and at each stage a varying number of horses are kept. In recent years owing to the dangerous condition of the Upper Road (9 miles) this part has been closed to traffic, the last station now being the Brewery (4,400 feet). The road, cut in the face of a cliff, and steep in places, winds in and out of the hills covered with jungle, and the stables at a lower elevation are more or less surrounded by thick vegetation, especially during the rainy season.

According to the statement of the late Sergeant-Major Brady, R.A., for some years Superintendent of this service, many horses, principally Cabule, succumbed to Surra previous to the year 1890. Since that date records are forthcoming, and the following table shows the mortality from Surra during a period of eight years.

Table

Showing the Rainfall and Mortality of Dâk ponies during Surra months (June to October from the year 1890 to 1897).

Stations.	Elevation.	Rainfall, 1st June to 31st October, in inches.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.
Naini Tal	... 6,350		123·02	81·85	63·73	126·91	105·19	85·10	63·85	114·93
Kathgodam	... 1,630		...	...	...	...	...	..	50·71	108·52
Haldwani	... 1,200		100·06	65·91	56·38	83·73	92·96	69·16	63 82	91·86
Average number of horses ...		...	90	93	93	180	128	131	101	80
Horses died (of Surra) between the Brewery and Kathgodam		...	40	10	5	2	63	8	92	2

The disease occurs during the rains, July to October inclusive, and usually makes its appearance among the horses stationed at Bhugiaghat (2,300 feet elevation), and later at the terminal depôt, Kathgodam (1,630 feet). Previous to the year 1894 it is not recorded that any horses had been attacked at the stables above Bhugiaghat, but during September and October of that year several animals contracted Surra at Bilwa-Khan on the Upper Road, and succumbed later.

When the horses are somewhat over-worked, as in 1891, the result of a heavy season, they are probably, as a consequence, rendered more susceptible: for the number of animals attacked with Surra have been observed to be more numerous.

The chief symptoms noted are, paroxysmal attacks of fever during the first two or three intermissions at which the animals appeared well enough to work, later, continuous falling off in condition, although accompanied by a voracious appetite; swelling and œdema of the limbs and under-surface of the abdomen. The conjunctivæ are frequently stained a yellow colour, and there are successive crops of sub-conjunctival petechiæ. After a varying period of illness the animals fall and are rarely able to rise again. Disease invariably fatal.

Bad water was supposed to be the cause of the disease, but this was rectified, and a fresh supply was obtained directly from the hills, which was first brought into use during the early part of 1892. Since June 1893 all water for the Tonga horses has been boiled at Kathgodam and the next two stages

up the ghat. The grass, instead of being obtained from the plains, has for years been collected during the cold season of the year (November to January) from the high-lands at an altitude of 4,500 to 5,500 feet; all corn and grain has been carefully cleaned and screened at Kathgodam (in order to avoid the presence of rat excrement *) before being conveyed to the stages, and the creeper (Bel) has not been utilized during the past two rainy seasons as fodder, as is the case on the Simla Dâk service.

It has been before mentioned that 'Surra' on this Dâk line usually appears first amongst the animals standing at Bhugiaghat, some four miles from Kathgodam, on the Naini Tal Road; the stables being surrounded on three sides by fairly thick jungle, which, during the wet season, is filled with dense vegetation.

Annually, soon after the setting in of the monsoon, the exact date varying in different years, fever makes its appearance in the animals at this stable, and later at Kathgodam; most of these cases of fever turning out to be 'Surra'. In 1896 all the animals, some twelve in number, succumbed to this disase at Bhugiaghat, and subsequently these buildings were closed for the season. In previous years the worst cases of fever only have been removed to the upper hills, but during the past one, for the first time, a stringent system has been introduced. On an animal being observed to be the subject of fever, its removal to a stable at an elevation of 4,500 to 5,500 feet has forthwith taken place, far away from the chaukis containing any of the other Tonga horses. Three animals have only been transferred during 1897, two of which, later, were found to be suffering from Surra, but no animals at any of the other stages have shown signs of sickness, although in 1896, 92 per cent. of the equines succumbed to this disease.

The small number of animals attacked this year may, on the other hand, prove to be a mere coincidence; this year being what we term a non-Surra year. But in previous reports we have pointed out that, according to statistics furnished †, the greater the rainfall the larger the number of cases of Surra in most parts of India. Now, this year, the rainfall from the 1st June to the 30th of September amounted to 114·93 inches at Naini Tal, and 107·90 inches at Kathgodam, and only two cases of Surra occurred among the horses of the Tonga service; and yet during the same period of 1896, a 'water-famine year', the Company lost 92 horses out of a total of 102. Another factor which has to be taken into consideration is that numerous 'Ekka' and riding ponies are kept at Kathgodam, and these are owned by natives who make use of no hygienic precautions to protect their animals from disease. The greatest mortality amongst these animals also occurs during the years that the Tonga horses are attacked, so that it would appear that both sets of animals are exposed to and contract the disease from the same cause.

After eliminating the sources (fodder and water) of the contagium of Surra to the Tonga animals, only two are left for consideration—

(i) If an animal contracts the disease through the disobedience and stupidity of its syce, *i. e.*, by allowing the animal under his charge to graze or drink by the way-side on the return journey to its chauki, the disease once started may be spread by the inoculation (bite) of flies ‡.

(ii) Flies may perhaps occasionally take into their systems the Surra protozoon or its resting form, when drinking the water of stagnant pools, and by this means be the carrier of the contagium to the animal it bites! But it is much more likely that the flies obtain the soiled material in the shape of blood from a previous case of Surra, either in equines, canines, or other animals.

It is, however, a *sine qua non* that if the Tonga animals are to be protected from Surra, all Ekka and riding ponies plying for hire on the road between Naini Tal and Haldwani must be placed under observation, and examined by a competent officer, during the Surra months 'June to end of October', and any animal presenting symptoms of fever must be isolated forthwith at a considerable distance, and the blood microscopically examined, from time to time, until proved to be free from the disease.

In no other Tonga service in India with which I am acquainted do the animals receive the same amount of supervision, care and attention as those under the Superintendent of the Rohilkand and Kumaon Railway Tonga Service, Kathgodam.

Riding and Ekka Ponies.—At Kathgodam numerous riding and ekka ponies ply for hire. These animals are owned by natives in the above mentioned station and Ranibág. During the rainy season these ponies are liable to Surra in the same way that the Tonga ponies suffer. This disease has been recognised for many years, especially previous to the time when the Rohilkand and Kumaon Railway was opened for traffic. In 1895, the Tonga service lost only eight of their horses, but private owners lost sixteen in Kathgodam alone. Unfortunately no supervision is exercised by the Police concerning the number of animals kept for the above purposes; consequently, no authentic statistics are forthcoming with regard to the mortality.

Bareilly, 1894.—One outbreak of Surra occurred in and around Bareilly. All the animals suffering from the disease died or were destroyed—(Raymond).

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* "One pound and a half by weight of rat's excrement was found by the late Sergeant-Major Brady in a sack of corn at Kathgodam".

† Punjab—(Saharanpur-Rájpur Dâk line).

‡ On September 5th, 1896, twelve horses standing in one shed were found, on microscopical examination of their blood, to be the subjects of Surra.

Commissariat mules working between Bareilly and Ranikhet.

On the 6th October 1894, ninety-six Government transport mules left Bareilly for Kathgodam, consisting of forty-eight pack and forty-eight draft animals. The distance between Bareilly and Kathgodam is sixty-six miles, and was completed in six marches. The animals, before leaving for the journey, presented a healthy appearance. At the second halting place, Dauranian, two marches from Bareilly, one mule died; at the third stage, four; at the fifth, one; and one at the sixth. On the arrival of the animals at Kathgodam, Veterinary-Captain E. Taylor was ordered from Lucknow to report upon the outbreak. He found the disease to be Surra, and shot four animals, and eleven died. Twenty animals were despatched to Naini Tal, and these returned to Bareilly without showing any signs of disease. Of the remainder, eleven were sent back to head-quarters, and the rest were taken to Ranikhet, *vid* Bhowali, where one succumbed, and eleven were destroyed between the 17th and 23rd October, and one animal succumbed at Bumsaon on the return journey to Kathgodam.

During the monsoon of 1894 very heavy rain fell, in all some 163 inches at Naini Tal and a trifle less at Kathgodam. The death-rate amongst the horses of the Tonga service was sixty-three out of a total of 128 or 49·22 per cent. It is needless to mention that the animals which left Bareilly on the 6th October apparently in good health, had Surra amongst them previous to starting on the march, for, one died at the second halting place and four at the third. It is a well known experimental fact that if a *large* quantity of soiled blood containing 300,000 Surra organisms in each one c.cm. be subcutaneously injected into a healthy horse, the parasite will not be detected in the circulation of the inoculated animal until the 4th to the 6th day, and, with the exception of the usual symptoms of fever, no other signs of Surra will be detected for some days, unless a few petechiæ invade the conjunctival membranes. When the Surra hæmatozoon was given in water to a healthy horse, the time occupied between the last administration and the appearance of the organism in the blood was seventy-five days (*vide* Surra Report, Vol. I, Horse No. XX).

Therefore the animals which left Bareilly in apparently good health must have contracted Surra at least several weeks before starting on their march to Kathgodam.

BOMBAY PRESIDENCY.

Ahmedabad and Baroda, &c., Districts.

In 1893, a large number of horses and donkeys died all over these districts. The city of Ahmedabad appears to have been spared this visitation, and also Dhandhuka, but it swept over all the rest of the district and the Gáikwári country to the north. A Resolution of Government postponed the Horse Show at Ahmedabad for two years.

It is not known whether Surra occurred in 1892, but probably it did. There is no doubt, however, that the excessive rainfall of 1893, the bulk of which fell during the month of July, in each year, was answerable for the disease appearing at the end of September, as the hæmatozoon thrives in a wet, warm and muggy climate. On reference to Vol. I it will be seen that Horse No. XX contracted the disease seventy-five days after imbibing the Surra hæmatozoon in water.

Table V.

Showing the Total and Mean Rainfall from 1889 to 1893 inclusive, and the Total Rainfall during the monsoon months of 1894, June to October.

Districts.	1889.	1890.	1891.	1892.	1893.	Mean for five years, 1889—1893.	1894, June to October inclusive.
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
Ahmedabad	24·89	22·75	25 59	51·18	43·75	33·63	51·33
Viramgám	21·67	25·79	34·79	55·06	35·58	34·58	39·63
Dhandhuka	27·07	12·20	23·13	36·97	26·26	25·12	57·88
Dholka	34·11	30·83	25·95	49·70	35·51	35·22	45·74
Baroda	45·88	38·23	29·50	37·06	44·62	39·05	64·01
Deesa	...	14·68	13·24	41·75	49·60	29·81	21·66

1894—A very severe and widespread outbreak of Surra (Zerbag) involving an area of some 400 square miles, and occasioning the loss of thousands of animals, was investigated by Veterinary-Lieutenant Axe in the Gujarát, Ahmedabad, Baroda and surrounding districts with special reference to the movements of Batteries of Artillery. The disease affected horses, ponies, camels and donkeys, nearly every

village in the affected district largely contributing to the mortality. The outbreak made its appearance about the beginning of October, and in six to eight weeks the affected animals were reduced to skeletons, and were in the last stages of the disease.

From Patan in Northern Gujarát all the villages on the route to Kharaghoda were visited, and in nearly all the disease had destroyed a large number of the horses, donkeys and camels.

In the Varavali Táluka of the Gaikwar Territory, which comprises about one hundred and fifty (150) villages, some fifty (50) were more or less affected centres, losing the majority of their animals from Surra. As a rule, wherever donkeys died in their wanderings the carcasses were allowed to remain and decompose, and to be the possible means of contamination of other places.

In the Viramgám District the disease was reported at Sinaj, Anandpur, Chanear and in the Cheemul Táluka.

As affecting the movement of the Battery from Ahmedabad, outbreaks were reported at Sánand, Goria, Patri and Kharaghoda. Further, disease was known to exist south of Viramgám, between Dholka and Dhandhuka Táluka.

Throughout the whole district under observation the rainfall for the year was very excessive, and a good deal of the country of Viramgám and Kharaghoda had been under water, conditions especially favourable for the development of this disease.

The rainfall for the year is shown in the following statement, the outbreak being favoured probably by the very heavy rainfall in the month of July :—

TABLE VI.

Showing the total rainfall in six Districts affected with Surra, for the months of June to October, inclusive, in 1894.

Districts.	June.	July.	August.	September.	October.	Total.
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
Ahmedabad	7·15	32·78	3·73	6·28	1·39	51·33
Viramgám	6·11	26·69	2·92	3·35	0·56	39·63
Dhandhuka	11·45	29·99	1·58	8·28	6·58	57·88
Dholka	8·30	25·27	2·89	7·18	2·10	45·74
Baroda	12·33	29·60	3·44	11·96	6·68	64·01
Deesa...	4·48	11·48	1·87	3·83	0·00	21·66

The symptoms noted were paroxysms and intermissions of fever, the presence of the infusorian in the blood, progressive emaciation and weakness, blood spots on the mucous membranes, slight mucous discharge from the nostrils and eyes, extensive swelling of the limbs, sheath, under-surface of abdomen, and chest, progressive anæmia, marked prostration, exhaustion and death.

Hyderabad-Deccan.

In 1893, the 1st Madras Lancers stationed at Secunderabad, lost some 49 country-bred horses from Surra.

Bombay Mounted Police Horses.

An outbreak of disease occurred amongst the horses of the Mounted Police stabled in and around Bombay during the rains of 1894. In all eleven animals came under our notice ; out of these two had been for several years in use previous to their contracting the disease. The other nine were purchased in June, July 1894. During the period which elapsed between the purchase of the animals and the appearance of Surra they were stabled in and around Bombay; their rations consisted of gram, bran and green grass.

The first horse to show symptoms of fever on 7th October 1894 was one used by the Inspector of the G Division, situated out at Máhim; two more in Bombay followed on the 17th October, during the month of November 7, and in December 1. Several of these animals were taken to the Bombay Veterinary Hospital at Parel, when the Surra hæmatozoon was discovered in their blood, and small doses of Arsenic were administered. At a later date the horses were sent to the Bacteriological Laboratory Stables and were submitted twice daily to increasing doses of Arsenic varying from v to xii grains in the form of Liquor Arsenicalis. One animal No. 115 was cured and is still in good health and condition.

TABLE. VII.

The following is a complete list of the animals suffering from Surra, sent to the Laboratory.

No.	Dates of				Result.
	Purchase.	Ailing noticed.	Hæmatozoa discovered.	Admittance to Laboratory Stable.	
109	24th September 1891 .	7th October 1894 .	11th October 1894 .	5th November 1894 .	Death.
110	24th „ 1894.	17th „ 1894 .	20th „ 1894 .	5th „ 1894 .	„
111	16th June 1894 ...	17th „ 1894 .	20th „ 1894 .	5th „ 1894 .	„
113	2nd „ 1894 ...	1st November 1894 .	8th November 1894 .	29th „ 1894 .	„
114	July 1894 ...	17th „ 1894 .	22nd „ 1894 .	29th „ 1894 .	„
115	„ 1894 ...	16th „ 1894 .	23rd „ 1894 .	29th „ 1894 .	Cured.
120	„ 1894 ...	27th „ 1894 .	4th December 1894 .	10th December 1894 .	Death.
121	„ 1894 ...	19th „ 1894 .	3rd „ 1894 .	10th „ 1894 .	„
122	„ 1894 ...	20th „ 1894 .	28th November 1894 .	10th „ 1894 .	„
123	13th December 1891..	14th „ 1894 .	7th December 1894 .	23rd „ 1894 .	„
124	16th July 1894 ...	7th December 1894 .	7th „ 1894 .	23rd „ 1894 .	„

Bombay.—During the year 1893, Veterinary-Major J. Mills discovered a horse in the port of Bombay, on its arrival from the Persian Gulf, suffering from Surra.

An outbreak of Surra occurred in 1893 amongst the horses of the Preventive Force stationed in Sind.

Cases of Surra are of frequent occasion during the latter months of each year in Bombay. Numerous animals are taken to the Veterinary College at Parel. In 1895 over a dozen horses suffering from this disease were admitted for treatment at the Bai Sakarbai Hospital for Animals—(Pease). I am indebted to Veterinary-Major J. Mills, Principal of the Bombay Veterinary College, Parel, for the following return of cases of Surra in equines during the years 1890—1897, inclusive.

TABLE VIII.

Showing the number of Surra cases admitted during different months from the year 1890 *to* 1897 *to the Bai Sakarbai Dinshaw Petit Hospital for Animals.*

Bombay Veterinary College.

Month.	1890	1891	1892	1893	1894	1895	1896	1897	Monthly Total for 8 years.
January	...	...	...	...	...	1	...	...	1
February	1	...	...	...	...	1	...	...	2
March	...	...	...	...	...	...	...	...	...
April	...	...	...	...	...	...	...	...	...
May	...	...	...	...	...	...	...	...	...
June	...	3	...	2	...	...	...	...	5
July	...	...	...	...	...	...	1	...	1
August	...	1	...	...	2	...	...	...	3
September	...	...	...	3	...	4	4	...	11
October	4	...	...	3	2	6	...	1	16
November	2	...	2	3	3	2	...	4	16
December	1	...	...	...	...	1	...	...	2
Total in each year ...	8	4	2	11	7	15	5	5	57

Bombay Tramway Company.

A letter was forwarded to the Managing Director of the Bombay Tramway Company giving information of an outbreak of Surra in Gujarát in 1893, and a more extensive outbreak in 1894 in the district from which the supply of hay for the Tramway horses was obtained, viz., on the black soil from Gujarát.

Upon receipt of this the Hay Superintendent in that district was communicated with, who supplied the following information, which accompanies a letter from the Managing Director of the Bombay Tramway Company, extracts of which are here subjoined :—

"I note your warning as to the care necessary in the selection of hay. I communicated at once with the Superintendent of our Hay Department, who is now in Gujarát, and I attach hereto copy of an extract from his reply. I will forward you the two samples of soil as soon as I receive them.

"I long ago regarded the green grass grown around Bombay—and most of which is raised on swampy land—as a possible source of infection, and have entirely excluded it from our stables the past four years. We also now import the whole of our lucerne supply from Poona.

"The whole of our dry hay is imported from Gujarát, and is grown chiefly in the Dakore District. It is composed chiefly of the variety of grass known as Zinjva, which does not like a very moist soil.

"We have lost this year to date 15 horses from Surra : 11 at our Parel Stables, and 4 at our Colába Stables—fortunately mostly old and infirm animals."

Extract from our Hay Superintendent's letter.

"On receiving your letter I at once made enquiries in the villages near about, and from that gather that early in September last a sort of a fatal disease was prevalent in the district among cattle and all sorts of animals. The first to be attacked were mostly buffaloes which died in a considerable number. Then it spread among cattle but not to a very great extent, and then it passed on to horses and asses. There are not many horses in the district, but several were affected and died. Among cattle and buffaloes the course of disease ran for only about 24 hours and ended fatally. The chief symptom, they say, was a swelling in the throat. As for the horses, the symptoms described, no doubt, indicate 'Surra'. The people here have no particular name for it. But with the advent of the cold season the disease has disappeared. It appears that such was the case almost everywhere in Gujarát. Kurim informs me that Kim District was also not free from it.

"As for the Kurans from which we obtain our hay, they are not of a swampy nature, nor are they liable to inundation. In this respect I think them to be better than Asudla and Bhal land. To give you some idea of the nature of the soil, I send per railway parcel samples of it taken from the Kuran. That marked No. 1 is the surface soil which is from 1 to 3 feet deep and that marked No. 2 is the subsoil.

"The spread of the disease was not confined to any one locality or district but was prevalent everywhere in Gujarát and in Káthiáwár also, and all kinds of animals fed or all sorts of fodder grown on all varieties of soil were affected by it. It also died out on the advent of the cold weather without the people taking any precautionary or preventive measures whatsoever, who consider it a visitation from an angry goddess. It is this year that the animals are largely affected. The season before last during the same period a virulent type of fever was prevalent among men, playing sad havoc in many places. All these make one incline to the theory that it is due more to climatic influences than to anything else, more so because for the past three years the seasons have been abnormal. Not only there is excessive rainfall during the monsoon, but during the cold weather too not a single month passes without there being a shower. I read to-day in one of the Gujaráti papers that on Wednesday last there was a heavy shower at Gogo at about 4 P.M. for an hour followed by hail-storm, an unusual occurrence there."

Dated Darkin, 23rd December 1894.

The following is an extract from a letter received from the Managing Director of the Bombay Tramway Company, dated the 7th December 1897, in which certain interesting points are brought forward as reasons for the late appearance and few cases of Surra during 1897 :—

"For several years past "Surra" cases have commenced in our stable in September, and we have had a few cases each month until the end of the year. This year we had no cases in September, October, or the first three weeks of November, and began to hope that we should escape any visitation of the disease. The last week of November we had, however, two horses (both Australians) attacked at our Parel stables, and another Australian attacked there this week. We have had so far no cases at our Colába or Tárdeo stables, at both of which we have had cases in previous years. In looking for the reasons of this immunity I have been inclined to attribute it to one of two causes, *viz.*, either (1) the fact that the bubonic plague infected and killed almost all the rats which up to this year have infected our premises, or (2) the very frequent and drastic disinfection of the soil of our stables with chloride of lime, carbolic acid powder, &c., which we have resorted to in consequence of the prevalence of the plague in city.

"Our own experience entirely confirms what you write as to the uselessness of forage and water precautions to insure immunity from the disease. The filtering of all the water used at our Parel stables, through a Berkefield filter, appeared to have no effect. The stoppage of green food also showed no result. This year we have not filtered the water and have given our horses liberal rations of lucerne.

"The particulars you give of the mortality amongst the Naini Tal Dák ponies are very interesting. They certainly go to support the view that the disease is greatly influenced by climatic conditions.

"I note, with much interest, your remarks on flies as propagators of the disease. We make it a rule to destroy immediately every horse, in which we find the specific microbe. Flies abound at our Parel stables, owing to the immediate neighbourhood of a large market".

The following charts give full details regarding the animals attacked in the Bombay Tramway Company's stables during the years 1893—1897 inclusive, in addition, meteorological charts of the city of Bombay showing the climatic conditions for the years 1893—1897, inclusive, during which the previous Surra cases occurred :—

1893.

Laboratory No.	Tramway Company Horse No.	Breed.	Sex.	Age.	Colour.	Date of Purchase.	Date of Attack.	Date of Death.	Time elapsing between Purchase and Attack.	Time elapsing between Attack and Death.	Remarks.
				Yrs.							
	367	Australian ...	.....	20	Bay	.....	20th July 1893	.....	.....	...	Destroyed.
	186	Persian ...	.....	10	Iron Grey ...	.....	20th July 1893	.....	.....	...	Do.
	32	Arab	.....	11	Grey	.....	21st July 1893	.....	.....	...	Sold.
	163	Anstralian ...	.....	10	Bay	.....	10th September 1893 ..	.....	.....	...	Destroyed.
	172	Arab	.....	11	Grey	.....	25th September 1893 ...	.....	.....	...	Do.
	268	Persian ...	.....	10	Grey	.....	25th September 1893 ...	.....	.....	...	Do.
	378	Anstralian ...	.....	20	Bay	.....	28th September 1893 ...	.....	.....	...	Do.
	633	Do. ...	.....	10	Bay	.....	29th September 1893 ...	.....	.....	...	Do.
	542	Do. ...	.....	8	Bay	.....	1st October 1893 ...	.....	.....	...	Do.
	688	Do. ...	.....	12	Bay	.....	16th October 1893 ...	.....	.....	...	Do.
	428	Do. ...	.....	10	Iron Grey ...	.....	6th November 1883 ...	.....	.....	...	Do.

1894.

									Yrs.	Days	Days.	
104	445	Australian ..	Mare... ...	11	Brown ...	10th April 1888	11th August 1894 ...	17th September 1894 ...	6	103	38	Pleurisy with effusion found *post mortem*.
107	536	Do. ...	Gelding ...	14	Grey	1st January 1886 ...	23rd September 1894 ...	4th October 1894 ...	8	272	12	Do do.
112	61	Persian ...	Do. ...	13	Do. ...	26th November 1887 ...	7th November 1894 ...	24th January 1895 ...	6	346	79	Lyphangitis.
116	388	Do. ...	Do. ...	11	Do. ...	28th January 1889 ...	29th November 1894 ...	17th December 1894 ...	4	305	19	
117	502	Do. ..	Do. ...	9	Do. ...	28th January 1890 ...	29th November 1894 ...	17th December 1894 ...	4	305	19	
118	128	Anstralian ...	Do. ...	16	Chestnut ...	14th January 1884 ...	3rd December 1894 ...	30th December 1894 ...	10	344	28	
119	822	Herati ...	Do. ...	8	Do. ...	21st January 1891 ...	4th December 1894 ...	2nd July 1895	3	318	211	Chronic poisouing by arsenic.
...	194	Australian ..	Do. ...	21	Brown ...	November 1881 ...	5th January 1895 ...	Destroyed	.....		...	
...	298	Do. ...	Mare	13	Chestnut ...	March 1887... ...	Do.	Do.	.....		...	
...	256	Country-bred.	Gelding ...	11	Grey	January 1890 ...	28th January 1895 ...	4th February 1895 ...	.....		7	

1895.

	568	Anstralian ...	Gelding ...	9	Grey	Jannary 1891 ...	2nd September 1895 ...	.....	.....	...	Destroyed.
	885	Country-bred.	Do. ...	7	Red Roan ...	January 1894 ...	9th September 1895 ...	.....	.....	...	Do.
	213	Anstralian ...	Do. ...	21	Bay	December 1878 ...	29th September 1895 ...	.....	.....	...	Do.
	189	Country-bred.	Do. ...	6	Chestnut ...	June 1894	28th September 1895 ...	.....	.....	...	Do.
	294	Anstralian ...	Mare	9	Nutmeg Grey ...	October 1891 ...	24th September 1895 ...	.....	.....	...	Do.
	543	Do. ...	Gelding ...	10	Brown	January 1890 ...	Do. ...	.....	.....	...	Do.
	786	Do. ...	Do. ...	7	Light Bay ...	November 1893 ...	11th October 1895 ...	.....	.....	...	Do.
	299	Country-bred.	Do. ...	10	Bay	January 1890 ...	20th October 1895 ...	.....	.....	...	Do.
	325	Do. ...	Do. ...	8	Bay	December 1892 ...	5th November 1895 ...	.....	.....	...	Do.
	772	Australian ...	Do. ...	12	Brown	December 1888 ...	15th November 1895 ...	.....	.....	...	Do.
	128	Do. ...	Do. ...	6	Bay	December 1894 ...	25th November 1895 ...	.....	.....	...	Do.
	50	Do. ...	Mare	12	Brown	December 1888 ..	6th December 1895 ...	.....	.....	...	Do.
	655	Do. ...	Gelding ...	6	Roan	October 1895 ...	7th December 1895 ...	.....	.....	...	Do.
	141	Do. ...	Do. ...	6	Bay	June 1894	21st December 1895 ...	.....	.....	...	Do.
	479	Do. ...	Do. ...	7	Dark Chestnut .	December 1894 ..	6th January 1896 ...	.....	.....	...	Do.
	535	Do. ...	Mare	11	Bay	January 1890 ...	3rd January 1896 ...	.....	.....	...	Do.
	39	Do. ...	Gelding ...	10	Bay	February 1891 ..	30th December 1895 ...	2nd February 1896 ...	.....	...	Do.

1896.

Horse No.	Date of Purchase.	Color.	Breed.	Sex.	Age.	Date when taken in Hospital.	Date when Surra Hæmatozoon found.	Remarks.
					Yrs.			
267	October 1891 ...	Grey	Australian ...	Gelding ...	12	17th April 1896 ...	9th May 1896 ...	Destroyed.
59	January 1890 ...	Bay	Country-bred ...	,, ...	12	12th August 1896 ...	31st August 1896 ...	,,
188	December 1884 ...	,, ...	Australian ...	,, ...	16	24th ,, ...	1st September 1896.	,,
806	November 1892 ...	,, ...	Country-bred ...	,, ...	10	2nd September 1896.	4th ,, ...	,,
104	December 1890 ...	,, ...	Australian ...	Mare ...	11	15th ,, ...	16th ,, ...	,,
574	February 1896 ...	,, ...	,, ...	Gelding ...	6	16th ,, ...	,, ,, ...	,,
952	December 1894 ...	,, ...	Country-bred ...	,, ...	8	,, ,, ...	,, ,, ...	,,
1067	,, 1895 ...	,, ...	,, ...	,, ...	7	15th ,, ...	,, ,, ...	,,
986	February ,, ...	Dun	,, ...	,, ...	6	21st ,, ...	23rd ,, ...	,,
735	October 1888 ..	Chestnut ...	Australian ...	,, ...	16	11th ,, ...	8th October 1896 ...	,,
238	December ,, ...	Roan	,, ...	Mare	16	5th October 1896 ...	10th ,, ...	,,
990	March 1895 ...	Grey	,, ...	,, ...	8	,, ,, ...	13th ,, ...	,,
949	December 1894 ...	,, ...	Country-bred ...	Gelding ...	8	8th October 1896 ...	14th ,, ...	,,
1049	February 1896 ...	Black	Australian ...	,, ...	5	31st July 1896 ...	16th ,, ...	,,
45	,, 1891 ...	Bay	,, ...	Mare	10	13th October 1896 ...	22nd ,, ...	,,
408	November ,, ...	Grey	,, ...	,, ...	11	,, ,, ...	,, ,, ...	,,
519	May 1892 ...	Chestnut ...	,, ...	Gelding ...	9	3rd November 1896.	6th November 1896.	,,
840	October 1894 ...	Bay	,, ...	,, ...	7	18th ,, ...	26th ,, ...	Died.
243	December 1890 ...	,, ...	,, ...	Mare	12	22nd January 1897 ...	26th January 1897 ...	Destroyed.

1893.

Month.	Barometer reduced to 32°	Temperature of Air.		Temperature of Radiation.		Temperature of Evaporation.		Computed Vapour Tension.	Relative Humidity.	Rainfall.	Remarks.
	Mean.	Mean. Maximum.	Mean. Minimum.	Temperature in Sun. *	Temperature in Sun. †	Mean.	Minimum.	Mean °F.	Mean °F.	Inches.	
January	29·907	81·1	66·3	132·5	58·0	66·5	60·9	·560	68	...	
February	29·938	80·3	65·2	1.4·1	57·6	65·7	60·0	·548	68	0·14	
March	29·866	84·8	71·6	138·6	65·6	71·4	67·4	·684	73	...	
April	29·797	89·3	77·9	141·8	71·9	76·0	72·0	·807	72	0·02	
May...	29·755	89·8	79·9	143·1	76·4	77·8	75·0	·871	75	6·30	
June	29·648	85·9	78·2	130·0	75·8	78·0	75·0	·899	84	21·47	‡First cases of Surra occurred 20th July. 1 Australian, 1 Arab and 1 Persian horse. Rainfall from 1st May to date of outbreak of Surra 39·41 inches.
July‡	29·687	84·8	76·9	131·9	74·5	77·1	73·9	·875	85	16·14	
August	29·728	84·2	76·8	1·9·1	74·3	76·5	73·9	·855	84	13·55	
September	29·775	84·5	76·1	134·0	73·1	76·0	73·3	·839	83	7·54	
October	29·826	87·2	74·9	138·7	68·0	75·4	71·2	·799	77	0·45	
November	29·899	86·9	74·3	135·3	67·3	73·7	69·5	·748	75	1·63	
December	29·958	85·0	70·7	133·1	59·3	69·1	64·8	·620	67	...	

1894.

January	29·928	83·1	68·7	132·2	60·6	68·6	63·6	·616	69	0·22	
February	29·920	84·0	70·9	136·5	63·5	70·3	65·3	·658	70	...	
March	29·855	86·4	74·3	138·0	68·9	73·0	68·7	·727	71	0·06	
April	29·787	88·9	77·9	140·5	72·6	76·9	73·7	·841	76	0·01	
May...	29·784	90·9	81·1	142·4	77·4	77·7	75·4	·858	71	...	
June	29·636	87·4	79·7	131·9	77·3	78·9	76·0	·929	81	16·87	
July	29·658	84·2	77·0	126·7	74·2	77·5	74·4	·893	86	26·16	
August§	29·694	84·7	77·3	133·4	74·6	77·0	74·1	·867	84	8·40	§First case of Surra occurred on the 11th August. Total rainfall from 1st May to date 44·09 inches.
September	29·758	83·1	75·7	129·5	73·7	76·1	73·4	·852	87	12·04	
October	29·806	85·6	76·1	136·9	72·6	76·6	73·0	·865	83	3·08	
November	29·933	86·2	71·4	138·3	63·5	70·8	66·3	·665	69	...	
December	29·945	83·2	69·3	132·9	61·8	69·7	65·2	·647	73	0·01	

1895.

January	29·930	80·7	66·8	127·1	58·6	67·2	61·9	·580	70	...	
February	29·926	83·0	68·2	130·5	59·7	68·3	63·2	·608	68	0·07	
March	29·840	86·1	73·9	132·2	66·5	73·4	69·1	·738	73	...	
April	29·803	88·5	77·1	135·2	71·5	76·0	72·5	·818	74	...	
May...	29·792	90·3	80·6	136·4	77·4	77·7	75·2	·861	73	0·08	
June	29·654	88·0	79·8	129·4	77·5	78·9	76·0	·923	81	17·84	
July...	29·689	84·7	77·7	124·4	76·0	77·6	74·6	·889	85	18·04	
August	29·704	83·9	76·7	124·8	74·7	76·7	73·8	·863	85	15·97	
September ‖	29·799	83·8	76·1	128·4	74·0	76·3	73·2	·851	86	11·91	‖ First case of Surra occurred on the 2nd of September. Total rainfall from 1st May to date 52·02 inches.
October	29·820	87·7	76·5	134·5	70·4	76·3	72·6	·831	77	3·62	
November	29·933	88·3	75·2	134·1	66·2	73·8	69·7	·754	70	0·06	
December	29·936	85·1	70·1	130·4	59·7	68·2	63·7	·596	63	...	

1896.

Month.	Barometer reduced to 32°	Temperature of Air.		Nocturnal Radiation Thermometer.	Temperature in Sun.	Temperature of Evaporation.		Compnted Vapour Tension.	Relative Humidity.	Rainfall	Remarks.
	Mean.	Mean. Maximum.	Mean. Minimum.	Mean.		Mean.	Minimum.	Mean °F.	Mean °F.	Inches.	
January	29·945	84·0	69·7	58·0	135·6	69·1	64·0	·628	68	...	
February	29·944	82·4	69·0	57·3	135·3	69·0	63·6	·629	70	...	
March	29·848	86·1	74·2	64·3	138·0	73·5	68·9	·743	73	...	
April	29·776	90·5	79·3	72·0	143·4	77·9	74·1	·869	73	...	
May...	29·796	91·5	82·1	77·0	144·3	79·3	76·9	·915	73	0·26	A sporadic case of Surra occurred on the 9th of May. No rain for 6 months previously.
June	29·618	87·6	79·6	76·4	134·5	79·5	76·2	·948	83	23·02	
July...	29·665	84·2	77·6	75·0	126·0	77·8	75·0	·908	87	36·44	
August	29·736	83·6	76·6	74·1	127·1	76·7	74·0	·868	86	20·77	Regular outbreak of Surra commenced on the 30th. Total rainfall from 1st May to date 85·49 inches.
September	29·821	86·6	77·6	72·6	140·3	76·8	73·8	·847	78	1·62	
October	29·878	90·2	78·7	70·4	139·9	78·0	74·2	·883	76	0·01	
November	29·865	88·2	75·4	65·9	135·3	74·0	69·2	·755	69	0·53	
December	29·953	85·9	71·9	62·2	137·0	69·9	63·9	·636	65	...	

* Solar radiation.

† Nocturnal radiation.

1897.

Month.	Barometer reduced to 32°	Temperature of Air.		Nocturnal Radiation Thermometer.	Temperature in Sun.	Temperature of Evaporation.		Computed Vapour Tension.	Relative Humidity.	Rainfall.	Remarks.
	Mean.	Mean.		Mean.		Mean	Minimum.	Mean F°.	Mean °F.	Inches.	
		Maximum.	Minimum.								
January	29·946	81·1	67·1	58·4	126·8	67·5	62·2	·599	69	0·01	
February	29·904	81·4	68·1	58·9	128·9	67·7	62·5	·597	69	...	
March	29·865	84·3	71·2	62·0	131·9	71·3	67·4	·693	73	...	
April	29·821	88·7	77·6	71·0	135·6	76·5	73·1	·841	74	...	
May	29·774	90·7	80·7	75·7	138·7	78·7	76·1	·908	74	...	
June	29·664	89·5	80·1	77·6	131·2	80·1	75·6	·966	79	1·4·40	
July	29·629	84·9	77·7	76·3	123·5	78·4	75·1	·936	87	30·19	
August	29·672	85·3	77·8	75·7	126·4	77·9	75·1	·917	85	13·82	
September	29·760	85·6	77·1	74·8	130·3	78·0	74·8	·917	85	20·60	
October	29·840	87·4	76·7	70·9	134·1	76·8	73·2	·863	73	2·51	
November	29·893	87·0	72·0	61·5	132·4	70·5	65·3	·653	66	...	First case of Surra occurred 26th November. Total rainfall up to date 81·52 inches.
December	29·951	84·6	68·7	54·3	128·1	67·5	62·2	·578	65	...	

Rajputana.

Jodhpore.—In the autumn of 1894, Surra attacked the Stud of Sir Pertab Sing at Pali, some eighty miles south-east of Jodhpore in Rájputána, when the losses among the brood mares were very heavy; fifty died during the months of September to November. Veterinary-Captain Hagger examined the blood of seven mares suffering with the disease on December 7th, 1894, and found the Surra hæmatozoon swarming in three instances, few in one, and absent from the blood of two. At a later date all these seven animals succumbed, and in addition others sickened and died.

Camels.

Bikanir.—An outbreak of Surra occurred among camels in Bikanir, Rajputana, in March 1891, and continued until 1894. The disease in this animal is said to pursue its course in certain cases for a period of three years, and for this reason, is termed "Tei-barsa," though many attacked with it succumb in less time. Surra is also known in some parts of Rajputana (Bikanir) as 'Sukal,' and in the Ajmere-Merwara District as 'Galtia' owing to one of the prominent symptoms being '*rapid wasting*,' '*drying up*' or '*melting away*' of the animal's body.

Camel-men and others state that the disease has been known in nearly every State in Rajputana for ages, and some camel-owners know it by all the above three names. Some believe it to be contagious, others that it is neither infectious nor contagious. Many say it is curable or rather that the animals recover from it, while the more intelligent argue that it is almost invariably fatal.

This disease has been enzootic in the Darbar Shutra-Khana and Stud for years, and in this department of the State it is estimated that thousands of camels have died from it.

The following statement shows the number of camels which died from the disease in the Shutra-Khána and Stud, from March 1891 to October 1894.

Table IX.

Showing the number of Camels died of the respective diseases, from 21st March 1890 to 6th April 1894.

Sambats.	Diseases.			Total.
	Tei-barsa.	Sukal.	Galtia.	
Sambat 1947 (A.D. 21st March 1890 to 8th April 1891).	96	...	22	118
Sambat 1948 (A.D. 9th April 1891 to 28th March 1892).	32	...	1	33
Sambat 1949 (A.D. 29th March 1892 to 18th March 1893).	23	...	18	41
Sambat 1950 (A.D. 19th March 1893 to 6th April 1894).	77	100	41	218
Total ...	228	100	82	410

(Signed) W. Loch, Colonel,
Political Agent, Bikánir.

The Ganga Risala Regiment was raised in 1889, and has been maintained at an average strength of nearly 400 camels. The disease first appeared among them in March 1891, and from that time up

to the 15th October 1894, 332 camels are reported to have died from it, and 99 were said to be still suffering.

The following table shows the number of camels which have died of Surra in the Bikánir Camel Corps from its formation in 1889 to October 15th, 1894 :—

TABLE X.

Showing the number of animals which have died of Surra in the Bikánir Camel Corps, made out to 15th October 1894.

Year.	Number of Camels died from Tei-barsa.												Total.
	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	
1889	...	...	...	...	...	...	...	...	...	...	...	...	...
1890	...	...	...	...	...	...	...	...	...	...	...	...	...
1891	...	...	4	1	6	2	6	3	8	2	1	9	42
1892	3	2	2	4	2	2	3	10	14	16	30	8	96
1893	20	5	6	11	18	19	17	7	3	2	8	4	120
1894	5	4	10	8	13	5	10	8	7	4	...	...	74
Total ...	28	11	22	24	39	28	36	28	32	24	39	21	332

(Signed) E. A. KETTLEWELL, Captain.

"The most prominent symptoms in the camel, in addition to the fever, are swellings which appear on the sides of the chest near the pad and in the sheath and scrotum of males, and in the udder of females. These swellings form into large abscesses containing an enormous quantity of thick cream-coloured pus. From the first to last there is progressive anæmia and, although the appetite generally remains good, the animal rapidly wastes away, until it becomes a mere living skeleton. The parasite is not present in the blood continuously during the whole course of the disease. The periods during which it is present are marked by elevation of the body temperature (fever), which rises in some cases to 106° F. and sinks to the normal during the intermission, when the parasites are absent. The disease is invariably fatal in the horse, but camelmen aver that a small percentage of camels, who can tolerate it for three years, recover."

(W. R. HAGGER).

BURMAH.

TRANSPORT ANIMALS.

Meiktila.—Mortality 76. This is a very healthy station, one of the best in the province; dry climate and animals do well there. It is the head-quarters of the Commissariat Department for the Southern Shan States and Keng-Tung. The animals employed on such duty carrying rations, both going and returning, have to pass through many miles of Terai and unhealthy valleys; in due course they contract Surra and return to Meiktila where they succumb.

Fort Stedman.—Elevation 3,000 feet. The animals contract the disease on the way to and from Bampon, and no doubt parts of the Hebo and Nyaungywe valleys are dangerous.

Mandalay is the head-quarters for many animals in the rainy season; most of the animals are employed in the open season carrying rations up the Chin Hills, &c. They start from *Kalewa* on the Chindwin and march for about 32 miles up the Kali valley (most unhealthy) to Kaleinyo, a regular death trap; from there they go to No. II stockade, 11 miles further on at the foot of the hills. From No. II stockade it is uphill. The Commissariat Department now keep up a large Transport Camp there during the open season. The camp is on an old clearing and a fine hill stream runs through it. There is little doubt, however, the Surra is enzootic in and around Mandalay.

Haka and Falam—Are situated at an elevation of 6,000 feet, and are very unhealthy. The animals which succumbed to Surra at the above stations contracted the disease in the deadly Kali valley round Kaleinyo and Natchigon.

Shwebo is a very healthy place. Surra contracted by animals on the road between that station and Kyankmyaung on the Irrawaddy.

Phabeikkyin, situated on the left bank of the Irrawady about the middle of the 3rd defile, and is the starting point for the ruby mines and Bernardmyo. The latter is a small ruby station, 6,000 feet elevation, some few miles from Mogok. All animals to get to their stations have to pass through a deadly piece of Terai, some 60 or 80 miles in length.

PONIES OF THE MILITARY POLICE.

So many deaths occurred in the Battalions stationed in unhealthy districts that it was deemed advisable to bring them down to the dry zone for the rainy season; however they started too late with the result that many animals died. The ponies are often at outlying stations in small detachments. Places like Bahmouk, Pyinlebu and Mause in the Katha District are dreadfully unhealthy.

Most of the ponies dying at Monywa were animals of the Upper Chindwin brought down for a change.

Myitchnia, Mogung } are bad places.
Bhamo. Often is bad.

Most of the Surra is not contracted in the stations, but is usually picked up at out-stations.

TABLE XI.

Showing the casualties of Transport animals (Mules and Ponies) in Burmah due to Surra from 1st April 1895 to 30th June 1896.

Stations.	1895.									1896.						Total.	Remarks.
	April.	May.	June.	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.		
Meiktila ...	...	...	...	12	35	26	1	2	...	...	...	...	...	...	...	76	
Fort Stedman...	...	...	...	...	...	...	...	...	2	2	...	...	...	...	1	5	Elevation 3,000 feet.
Mandalay ...	1	...	2	6	19	14	10	3	6	2	4	1	4	3	33	108	July 16th, 1896. Surra now prevalent amongst Transport animals.
Fhabeikkyin ...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	9	10	
Shwebo ...	...	...	...	...	...	1	2	2	10	4	...	...	...	1	...	20	
Bernardmyo ...	...	1	...	...	1	7	8	9	16	4	3	...	...	...	...	49	Elevation 6,000 feet.
Myingyan ...	...	...	...	...	...	2	...	...	...	...	...	...	...	...	...	2	
Kalewa ...	...	...	...	...	...	...	...	2	...	...	...	...	...	...	...	2	
Haka	...	...	1	...	...	12	18	17	...	...	...	...	...	...	...	48	Elevation 6,000 feet.
Falam	...	...	...	...	7	6	24	9	...	...	...	...	...	...	...	46	Do. 6,000 feet.
Total ...	1	1	3	18	62	68	63	44	34	12	7	1	4	5	43	366	

TABLE XII.

Showing number of Ponies of the Military Police that died from "Surra" as below.

Stations.	1894.	1895.	Remarks.
Mandalay	53	2	Much rain. July 16th, 1896.—Surra now prevalent amongst the Commissariat Department Transport animals.
Bhamo	1	...	Do. do.
Mogaung	6	23	Do. do.
Katha	25	26	Do. do.
Mogôk	3	3	Do. do.
Lashio	5	...	Drier.
Mônywa	25	9	Drier.
Yamethin	9	3	Dry.
Pyawbwe (Yamethin)	16	19	Dry.
Shwebo	5	1	Dry.
Meiktila	2	30	Dry.
Pakokku	1	...	Dry.
Magwe	4	6	Dry.
Gaugaw (Pakokku)	...	2	Much rain.
Myikyina	...	21	Do.
Pymmana (Yamethin)	...	42	
Pegu	...	12	
Total ...	155	199	

SOME NOTES ON SURRA IN BURMAH.*

Outbreak amongst Military Police Ponies at Mandalay, July 1896.

A number of ponies, Mounted Infantry and Transport, of the Yamethin Battery, arrived at Mandalay from Yamethin on the 26th April 1896.

On the 1st of June a pony was found to be suffering from fever, and also showing suspicious symptoms of Surra; he was promptly segregated, and treated with Arsenic. This animal died on the 23rd June. No microscopic examination of the blood was made. This pony had been to Zagobin and May-myo; he is supposed to have contracted the disease on the road.

Case 2.—This animal had been in poor condition for a long time, so was excused duty, received tonics including Arsenic, also an extra ration of grain. On the 1st June he was admitted suffering from fever, a few days later the case became very suspicious, so the animal was isolated. He died on the 29th June. There was no microscopic examination of the blood. A noteworthy fact about this case is that the pony had not been out of Mandalay.

On the 20th July there were twelve cases of fever in the sick-lines, an examination of the blood was made in all these cases, and two animals were found to be suffering from Surra. Both animals were destroyed.

On the 22nd June a transport pony arrived from May-myo, showing suspicious symptoms of Surra. The case was segregated, however, on the 7th July; the Commandant being satisfied that the case was Surra, had him destroyed. It is suspected that the disease was contracted on the May-myo road.

The ponies of the battery have not been allowed out to graze; the grass (Doob) is brought in by Burmans, and is always dried in the sun for at least one day before it is given to the animals. The allowance is thirty pounds for each pony; the grain ration is paddy, quality good; ration for Mounted Infantry five pounds, and for transport animals four pounds per diem. Water appeared to be of excellent quality.

The buildings used as stables are long sheds with thatched roofs. The lines are kept in a sanitary condition.

There is a Police Post at May-myo, which is situated on the Shan plateau at an elevation of 3,600 feet, and is some forty miles distant from Mandalay.

The stages are Tonbo, Nyaungbaw, and Thondaung. Tonbo is at the foot of hills, the land is low-lying, *i. e.*, paddy fields, &c., &c.; there is a good deal of bamboo jungle about. The Tonbo stream runs alongside of the road, but once the rains commence, pools of stagnant water are formed all over the place. The grass obtained here is rank.

Nyaungbaw is on the Zebingyi plateau. Water from a running stream; the grass is coarse.

Thondaung.—Good grass is procurable, but that growing on low-lying parts is most inferior. Water-supply from a running stream.

May-myo.—The grass excepting in the swamp and its vicinity is good. Water from wells and stream.

The Commandant informed me that all his ponies did well at May-myo. Thirty animals, very poor in condition, were sent there as an experiment, and every one of them picked up wonderfully. The ponies have been changed once a month. May-myo is certainly a bad place for Surra; if I remember rightly, a certain Mountain Battery came down from Bhamo, as it was unhealthy for the mules, and went to May-myo. The result of the change was anything but satisfactory, for they suffered heavy losses from this disease.

Mandalay.—On the 28th July I visited the lines, and found that several ponies had been isolated owing to having abnormal temperatures. I determined, however, to examine specimens of the blood of all animals in the lines, the result being that I discovered thirteen cases of Surra; these were isolated. On the 30th I examined all animals found fit on 28th, and discovered two more cases. On the 1st August I found a fresh case and on the 5th two more cases, one from among the line ponies, the other out of a batch of animals that had arrived from May-myo the day previous. I destroyed sixteen of these cases, and placed the remaining two under treatment.

A party with twenty-three ponies left Mandalay on the 16th May and returned on the 21st. Nos. 12, 13, 14, and 15 were of this party.

With regard to the *post-mortem* appearances of this disease in Burmah, one lesion is rarely if ever absent, *viz.*, some change in the mucous membrane of the stomach, more especially of the cuticular coat, pigmentation, erosion, or ulceration. The positions in which these changes are most constantly met with are along the line of junction of the cuticular with the villous portion, and also at the lesser curvature. If an animal be destroyed during the early stages, discoloured muddy yellow patches may be observed; if examined closely, one or all of them may present an eroded appearance. These changes are in most cases no doubt due to thickening and proliferation of the epithelium which degenerates and breaks down, leaving the yellowish shallow ulcers; these, owing to progressive degenerative changes, become deeper, until in many cases, perforation occurs. The ulcers may cover an extensive surface. I have seen some six or seven cases, in which from half to three quarters of the cuticular coat was in an ulcerated state, and it was while making *post-mortems* with another officer of the department that we

* Veterinary-Captain G. H. Evans, Superintendent, C. V. D, Burmah.

came on two of the cases referred to, and in which, no less than three quarters of the cuticular surface was involved. The animals from which these stomachs were taken were destroyed, as they were suffering from Surra; neither were in bad condition, and were taking food up to the very last moment. Though the cuticular coat is invariably involved, the lesions undoubtedly do in some cases extend to the villous portion. The anatomical differences, however, naturally, to some extent, alter the appearances of the ulcers, which are often seen with a smoother flat surface, and surrounded by a ring of swollen mucous membrane.

I am of opinion that in all cases of death from Chronic Surra, or in animals that have been destroyed after the disease has been in existence for some time, that ulceration of the stomach, more or less extensive, will be seen *post-mortem*.

The deep yellow pigmentation is not constant, but in nearly all cases there is a distinct yellowish tinge about the cuticular coat. The villous portion often is in parts, owing to degenerative changes, denuded of its epithelial lining. In some cases a large portion of the cuticular coat may be pigmented. The colour is a bright yellow, which shows up beautifully alongside of the whiteness of the normal epithelium. Parasites (Spiroptera microstoma) are constantly found, especially in the stomachs of mules, embedded in the gelatinous mucus on the villous coat, but, as you are well aware, have nothing to do with the disease. Bots are frequently met with, and this year I met with a case where the bots had attached themselves to the mucous membrane of the duodenum; there were quite one hundred. Spiroptera nests are sometimes seen in the stomach. I think more frequently in mules, but they are rare. Last month I was present at forty-one *post-mortems*, but did not observe a single nest. I have heard it stated that feeding on unbruised paddy might cause gastric ulceration; if this was the case I am certain that I would have noticed it in *post-mortems* on animals that had not succumbed to Surra. In Lower Burmah the people rarely give their animals anything else (Rangoon not included). I always feed my Burman ponies on paddy and never think of crushing it.

I have never observed ulceration of the small intestines, but have noticed circumscribed local congestions. In a few cases extensive mucous congestion was noted. The intestines often contain a quantity of a very yellow fluid. Nothing remarkable to note about condition of the large intestines. In advanced cases the spleen is generally enlarged; there is, as a rule, an excess of pulp, so that it pits on pressure. The structure is at times disorganised.

The liver is usually very healthy; cases of congestion, softening, may be met with; miliary calcareous deposits are often seen. In some cases the organ is much enlarged. I have noticed flukes in the livers of some cases.

Kidneys.—These organs are frequently affected, at times anæmic and œdematous, at others slightly or markedly congested. I have observed in some cases considerable blood extravasation, on and in the under-parts of these organs.

The lymphatic glands are frequently found in an œdematous state.

The heart has gelatinous accumulations in its furrows, instead of fat. In chronic cases the organ is pale, flabby, very often enlarged, and very soft. The cavities are filled with blood, or variegated clots, which extend into the great vessels. On several occasions I have seen the aorta in an atheromatous state. The heart constantly presents some abnormal condition, the more frequent being sub-endocardial ecchymoses more or less extensive.

The lungs are, as a general rule, healthy, but cases in which they are congested are by no means infrequent.

I have examined the brain and cord carefully, but have never discovered much; in a few instances the brain substance was undoubtedly soft, and the plexus choroides pale and bloodless. There is little to note about the bladder; in some cases a patch of extravasation may be observed at the fundus, or small petechial spots scattered over the mucous membrane. Carcasses of animals that have died from this disease present a dreadfully emaciated appearance, only skin and bones. There is, as a general rule, an anæmic condition of all organs, and absence of fat. In some cases there is an excess of fluid in the abdominal and thoracic cavities, also in the pericardial sac. Rigor mortis is normal.

Chin Hills.—The dangerous part of this road lies between Kalewa and No. 2 stockade. At Kalewa the animals should only be watered from the river. Grass might easily be brought up by steamers from Mandalay or other station.

Natchigon.—Water from the Myit-tha river. Grass and straw should be stacked. Kalemyo Camp at Pyinthazeik. Water from the river. Grass stacked. No. 2 stockade. Water-supply from a mountain-stream near camp. Grass ought to be collected here. I think the waters of the rivers are safe enough.

Bernardmyo.—The Terai between Tabeitkyin and Shyenyoungbin is very unhealthy. At Tybeitkyin the transport should take water at the Irrawady (all back waters must be avoided). Grass is very bad, should be collected at Tabeitkyin, Wahpyudaung, Kyauklebin and Shwenyoungbin. After January only dry bamboo leaves and thatch grass are obtainable within easy reach of camp, so after the first couple of storms there is a rush for any green fodder.

Kengtung.—I do not know the road beyond Taung-gyi, about 130 miles from Meiktila. Transport should be watered at Hlinedet and Yemabin from good wells, a Pyinoungand Nampandet from the river, and at Wetpyuyet, Kalaw, Thamakhan, Heho, Bwethet from wells, as I think the ordinary waters are suspicious. Grass ought to be collected at Hlinedet, Yemabin, Pyinoung, Nampandet, Wetpyuyet and Kalaw. Quantities of good grass can be obtained from Kalaw onwards.

Prevention of Surra.

From what I know of this malady I am convinced that it is impossible to prevent its occurrence in tracts where the disease is endemic. As Government transport have to pass through such tracts every season carrying rations to stations in the Chin Hills, Bernardmyo and Kengtung, I am of opinion that much can be done towards reducing the terrible annual mortality.

To begin with, now that there are permanent camping grounds on the roads to the Chin Hills and Bernardmyo, and the date on which the rationing will commence is known for some time previous, I see no reason why a certain number of muleteers under good non-commissioned officers should not be sent off a month before the animals are expected to arrive to each of the suspicious camping grounds. During this period grass could be collected, dried, stacked in sheds at a trifling cost. Ten men working at each camp ought to collect 15,000 to 18,000 lbs. of grass in a month. In places where paddy straw is procurable it might also be stacked and used as chaff. I would recommend that these grass-cutting parties be permanently employed during the working season. Good fodder can be procured during the months of October, November, December, and part of January. If this suggestion is carried out sufficient fodder could be collected to carry the animals through the remaining months of the open season. All men selected or volunteering for this employment should be subjected to strict medical examination, and only those who are strong and who have not been subjected to fever be allowed to proceed. In order to prevent mules grazing while on the march, I would suggest that a muzzle be provided for each animal; they should be put on before the mules leave their standings, and on no account removed till they are tied up at their pickets at the next camp.

As matters now stand, it is impossible to condemn a day's grass supply, no matter how bad it may be, as the animals would have to go without.

Water-supply.—A good well should be sunk at each of the bad camps. The open wells now found in camps are not to be trusted, as in a great many cases they have been sunk in such low-lying places that during the rains no trace of them can be seen; thus all manner of filth and organic matter gain entrance into what is supposed to be a good drinking water. Tube wells might be employed; they are portable, inexpensive, and, I understand, easily sunk. These would yield a purer and clearer water than that obtained from open wells, ponds, &c., &c. Two or three troughs or dug-outs for watering purposes could easily be made. A non-commissioned officer should be held responsible that mules are not allowed to water at any place than that provided for the purpose. In the Chin Hills I have seen native trader's ponies, Panthe mules, caravan cattle, all drinking from the same places that Government animals are watered at. All wells, &c., where Government animals are watered at, should, if possible, be fenced in, and drinking places provided for outside animals.

Sanitation.—The importance of keeping all camps in a clean state should be impressed on all persons in charge of convoys. Every standing should be cleaned and all stable refuse, litter, dung, &c., &c., must be burned daily by a fatigue party. There is no excuse for allowing refuse to accumulate month after month. Where space permits, camping grounds or rather the standings should occasionally be changed. Panthes and caravan people should not be allowed to camp on our grounds. Animals must not be crowded, plenty of room between pickets should be allowed to permit free circulation of air.

Animals which are to be sent on rationing might be put on Arsenic for some little time before starting; it should also be given in small quantities, now and again, while the animals are working in these unhealthy places, but this of course could only be done when proper supervision is provided. I am of opinion that this drug should not be placed in the hands of salutris and other natives.

The rationing should be done as quickly as possible, as I feel sure that there would be less Surra if arrangements were made to enable animals to be moved from infected areas by the first week in April. The June outbreaks point to the disease being contracted during the latter end of April and early part of May. Heavy thunderstorms occur about this time, followed by excessive moist heat. Organisms which lie dormant during the hot season suddenly become active, and assume fresh phases of development; the rain being particularly heavy, all kinds of active organic matter is washed into tanks, marshes, &c., &c. The tired muleteers are only too delighted to obtain grass near at hand, and are not in the least particular as to how they cut it; the result is that quantities of grass are cut beneath the surface of the water, and as there is no time to dry it, it is placed before the animals with the portions that have been submerged, covered with slime and other filth, which is well-known to harbour all manner of low organisms. Fatigue, exposure, indifferent and insufficient food, no doubt as with other ailments act as predisposing causes.

In the Military Police we find that the earlier we bring ponies down to the dry zone the less animals we lose. This year, as far as I am aware, we have not lost any animals out of those brought down from stations like Katha. Last year we did not get them down till end of May and beginning of June, the losses were very heavy. This season the transport working on the Ruby Mines Road did not return to head-quarters till some time in June, the losses amongst these animals will be terrible. (Between April 1896 and April 1897, 220 mules succumbed to Surra in Mandalay).

Undoubtedly one great fault is the utter want of knowledge of animal management on the part of the natives in charge; some in time may gain experience, still it is expensive for Government. The salutris and jemadars I have met over here are incompetent to give any sound advice on matters affecting the health and welfare of animals, and are only just able to treat the most simple ailments. As long

as there are defects in the feeding, watering and general care of transport, so long will the animals suffer severely from enzootic diseases. While at head-quarters the greatest care is taken to see that the animals get good dry grass, excellent water, that they are properly and regularly groomed, and that the stables, standings and vicinity are kept in a sanitary condition, yet when these same animals are called upon to perform severe work, and require, if possible, even more care than when in cantonments, they are handed over practically to the tender mercies of transport jemadars and muleteers. These men are very willing, and, when looked after, excellent men for the work which should be required of them.

Two points which I wish to bring particularly to your notice are :—

(*a*) the urgent necessity of providing ample European supervision with Government transport ; and

(*b*) the desirability of getting the rationing over as early as possible, even if extra animals have to be employed.

Hired Transport.—In this province bullock and mule transport can both be obtained. Pack bullocks are slow, easily stampeded, and as baskets are employed for carrying purposes, it is necessary that Government packages be undone. The bullocks carry from 140 to 160 lbs. The risks are of contracts not being fulfilled if foot-and-mouth disease or rinderpest should attack the animals. The advantage is that it is inexpensive.

Panthe and Yunnanese mule transport, if obtained at moderate rates, must prove a saving to Government. Government has no risks, with mules all work is pretty sure to be carried out. Government could considerably reduce their permanent transport, thus saving keep and establishment.

All work must be pushed through as quickly as possible, as the Panthes are well aware what the results will be if they are kept out too long. These muleteers are willing, cheery and hard-working, if treated well. The mules being small, they can only carry from 120 to 130 lbs., and the men naturally resent any attempts at over-loading. I have little doubt that if due notice be given ample transport will be obtained.

When prevalent.—April is the only month in which I have up to the present not met with a case of Surra. The heaviest mortality usually occurs between June and October. June, July and September may, I think, be taken as particularly bad months, though outbreaks severe enough occur in August and November.

As in India we meet with this disease in two different climates, *viz.*, in places where there is a moderately high temperature, an atmosphere charged with moisture, heavy rainfall and considerable inundation of country ; also where the climate is dry, the temperature very high, and the rainfall moderate or slight ; it must, however, not be overlooked that in such places, though the register may show only a moderate amount for the year, the rain at times comes down so hard and fast that tanks are quickly filled and low-lying tracts inundated.

Surra prevails at certain seasons throughout Upper Burma, also in the Shan States, and the Chinese say that at times it is very bad in Yunnan. In some years the Chinese suffer heavy losses along the trade routes from Bhamo. In Lower Burma one does not hear so much about Surra, for the simple reason that columns do not go out, and most of the animals are in the hands of private individuals who look after them. In 1890, I witnessed one bad outbreak in the Thayetmyo District. Mr. Steel saw it in Toungoo and Rangoon. I have to note an outbreak amongst some private animals in Rangoon. The first case brought to my notice was on the 17th of September of this year, and is the first case I have met with in an animal that had not been out of the station. I will let you have some notes on it later on.

It is surprising that Burmans, owing to their system of feeding ponies, do not suffer heavier losses. The grass is chopped up and mixed with water ; grain is frequently given in the same way. The reasons given me are :—1. That their forefathers always fed animals in this way and found it answer well. 2. That ponies must digest their food as they cannot bolt it. 3. That owners are too lazy to clean the grass and grain, so mix it with water. This is probably the correct reason. A great many cases must arise from eating bad grass. We all know the customs of ordinary grass-cutters, so we can hardly blame the tired muleteers for obtaining grass with the least possible labour from swamps, ponds, or the beds of recently dried tanks or nallas. The state of these latter places, just as the evaporating process approaches completion, is horrible ; simply a mass of foul-smelling putrid green slime, containing myriads of low organisms. Stacking grass would at least, to a great extent, protect animals against this source of infection.

Period of incubation.—I regret I cannot afford any accurate information ; I should think from twenty-five to seventy days or even longer. Mules and ponies, old and young, male and female, of all sizes and colours, are attacked and die of the disease. I do not believe that sex, age, colour, or breed exercise any influence in the matter. Animals in the "Pink" of condition succumb, as or even more rapidly than those that are weak and in a debilitated state. Burman ponies and Panthe mules contract the disease as readily as imported animals. We will no doubt hear a good deal about flies serving as transmissive agents, now that Dr. Bruce has established the fact in connection with the "Nagana" or "Tsetse fly" disease. As in South Africa I am certain the flies possess no specific venom ; though I have never served in Africa, I venture to state that certain tracts in this province could compete very

favourably with the special "fly tracts" of any other country. In Burma they are particularly bad after the first few thunder-storms, *i.e.* the end of April and early part of May. Indeed they are so troublesome that Burmans when obliged to take carts, &c., through them, take the precaution of making torches of strips of bark of one of the wood-oil trees, I think the *Dipterocarpus Lævis*; Burmese (*Kanyin-ni*). After lighting the torches they tie a bundle of green twigs with leaves on to make them smoke well. One is tied to the yoke between the oxen, the driver carries another to protect himself, and drive the flies from the back and sides of the bullocks. In spite of these appliances men and animals are often severely bitten. Baggage elephants, with trunks and tails swinging, do record trips through such places. I have not observed the cattle or ponies in these parts looking any worse than animals out of these tracts. The Burmans laugh at the idea of these flies provoking any ailment beyond sores, at times resulting from the bites. I have frequently examined many kinds of horse and cattle flies in different tracts, and at different seasons of the year, but so far without results. If flies are removed from the body of a Surra patient, hæmatozoa may now and again be seen, but I examined many specimens before I detected them, and then only in a fly which had been feeding on soiled blood. That flies may carry soiled blood I am prepared to admit. The ordinary Bara Dhang could easily do this; still I am of opinion that only a small percentage of animals become infected in this manner; however time may show that they carry the hæmatozoon about, a great deal more than we at present give them credit for. Feeding on coarse rank grass which wounds the mouths, tongues, of animals endeavouring to eat it, affords ample means for the entry of the infusorian, especially so when they have to eat marsh grasses, after a course of thatch grass, and drink bad water. There can be no question that the hæmatozoon is the cause of the malady; it is to be found in all cases of Surra, and all equines in which it is seen, as far as my experience goes, will most assuredly die.

I have often heard men say that they have known Burman Doctors to cure Surra, and that when stationed at such and such a place a Burman cured two cases, &c., &c., such animals having to their certain knowledge worked for two years after. These were no doubt cases of that peculiar form of bilious fever which very closely resembles Surra in many of its symptoms, and which I described to you. You also met with the same disease in Poona. I think we can safely say that no Burman ever cured a case of the disease we know as Surra.

I have given Burmese Doctors every opportunity and assistance, and have offered a large reward; though they have on several occasions accepted my offers, they have, after a week's trial, given the patients up as hopeless, stating that they had mistaken the nature of the malady.

No doubt the most striking feature of the disease is the wonderful appetite of the affected animals, and the manner in which they, in spite of food, rapidly become living skeletons. It is a distressing sight to see an animal down, with its heart thumping violently, and veins of head distended, still struggling to eat. I have many times seen an animal drop dead while eating, and have several times propped them up when unable to stand into the lying posture, when they have at once commenced to feed and have died in from twenty to thirty minutes after. Even with very high temperatures they will always take grass but may refuse grain.

Urticaria is not nearly so common as in India. Œdema is common enough, especially among the larger patients.

Constipation is the rule, diarrhœa the exception. The dung natural at first; later on, it is of a light brown colour; towards the close it is frequently pultaceous and possesses a foul odour.

The urine from Surra patients varies a great deal, sometimes viscid, at others not; in colour it varies from a reddish to a greenish yellow. As a rule, it is alkaline in reaction, but towards the close is often slightly or distinctly acid. I have failed to detect the organism in the urine, but blood and granular looking casts are common enough. In some cases small quantities of albumen may be present.

Spiroptera nests are distinctly rare. During this season I have made upwards of sixty *post-mortems*, and in only one case did I observe a nest.

Ordinary parasites are constantly met with, and now and again flukes. This year I came upon a very bad case; there must have been quite two hundred parasites in the liver, which organ was much enlarged.

Table XIII.

Showing certain details concerning the ponies destroyed in Mandalay on account of Surra, together with the pathological changes found in the stomach, and the weight of the principal organs in each case.

No.	Description.	Height.	Age.	Condition.	Temperature.	Hæmatozoa.	Date of Destruction.	Stomach.	Heart.	Liver.	Spleen.	Kidneys.	Remarks.
		Ft. in.	Years.		°F.				Lbs. oz.	Lbs. oz.	Lbs. oz.	Ozs.	
1	Gelding ..	12 2	8	Excellent .	102·2	Swarming.	1st August 1896.	Slight ulceration of cuticular coat.	2 9	6 12	2 0	12 each.	No œdema and no urticaria.
2	Mare	12 0	13	Poor ..	103·0	Do. ..	Do. ..	Do. do. ..	3 8	7 12	2 8	14 do.	Miliary calcareous deposits throughout substance of liver. Petechiæ lying under the epicardium.
3	Gelding ..	11 2	13	Fair ..	105·0	Do. ..	Do. ..	Marked ulceration ..	3 6	7 6	2 6	16 do.	Few calcareous nodules in liver. Heart hypertrophied with dilatation.
4	Grey gelding..	12 1	8	Do. ...	101·2	Do. ..	Do. ..	Do. ..	3 4	7 12	2 10	14 do.	Perihepatitis and calcareous deposits throughout substance of liver and both lungs.
5	Bay mare ..	11 2	11	Excellent .	100·2	Few ..	Do. .	Slight ulceration, pigmentation marked.	3 0	7 14	3 0	13 right. 14 left.	Extensive endocardial ecchymoses.
6	Chestnut gelding.	12 2	10	Fair ..	104·0	Swarming.	Do. ..	Marked ulceration ..	3 4	6 4	2 0	14 left. 13 right.	Liver firm, but of a very pale brownish yellow colour.
7	Bay gelding ..	11 3	11	Do. ..	101·4	Do. ..	Do. ..	Ulceration moderate, walls thick.	3 8	8 12	3 8	14 each.	Œdema of sheath. Liver and spleen enlarged, sub-capsular petechiæ of latter organ. Sub-endocardial ecchymoses.
8	Bay gelding ..	12 2	10	Very good.	100·4	Few ...	Do. ..	Ulceration well marked.	3 0	6 8	2 12	14 do.	Old endocardlitis with thickening of mitral valves.
9	Dun gelding ..	11 0	8	Poor ..	101·0	Do. ..	3rd August 1896.	Ulceration slight, eroded patches.	2 12	8 8	2 0	13 do.	Calcareous deposits numerous throughout substance of liver and both lungs.
10	Grey gelding	12 0	14	Do. ..	104·2	Swarming.	1st August 1896.	Ulceration free, pigmented and circular white patches.	3 9	7 14	2 14	14 do.	Calcareous deposits numerous, lungs and liver. Circumscribed collections of blood beneath capsule of spleen. Sub-endocardial ecchymoses.
11	Chestnut mare.	12 1	8	Fair ..	105·0	Do. ..	3rd August 1896.	Extensive ulceration.	2 14	8 8	2 0	14 do.	Sub-endocardial ecchymoses. Small extravasations of blood under epicardium.
12	Bay gelding ..	11 3	5	Do. ..	105·0	Do. ..	Do. ..	Extensive ulceration pigmented patches.	3 8	9 6	3 12	14 do.	Œdema of limbs and sheath. Heart hypertrophied, old endocarditis. Old pleuritic adhesions. Large cicatrix on left lung.
13	Chestnut mare.	12 1	7	Poor ..	104·2	Do. ..	Do. ..	¾ cuticular coat ulcerated.	3 0	8 15	2 10	14 do.	The stomach was in a terrible state, ulcers large, all but perforation. Sub-endocardial extravasation.
14	Bay gelding ..	12 0	6	Good ..	104·0	Do. ..	Do. ..	Considerable ulceration.	3 2	8 0	2 3	15 do.	One ulcer 1½ inches in diameter was surrounded by a broad band of yellow pigment.
15	Grey gelding..	12 0	8	Fair ..	103·2	Do. ..	Do. ..	Slight ulceration ..	3 4	6 11	2 10	13 do.	Stomach discoloured, many eroded patches.
16	Black gelding .	12 0	11	....	100·4	..	Do. ..	Do. Patches of erosion.	2 10	9 10	2 8	12½ do.	Spleen sub-capsular petechiæ. Heart, soft, flabby, and walls much thinned.

Veterinary-Captain Evans narrated the following account of an outbreak of Surra in a private stable in Rangoon during his recent visit on deputation to Muktesar. As it is of such importance to owners of equines in many districts of India where the disease is enzootic, I have added it to this officer's notes on Surra previously recorded.

On September 17th, 1896, an outbreak of Surra occurred in the cantonment among the horses belonging to a Civilian; no case had been observed during the previous seven years in Rangoon, with the exception of two or three animals which arrived from Upper Burmah with the disease; in them the malady was speedily diagnosed and the ponies destroyed. The animals kept by the above gentleman consisted of selected Country-Breds, Burman ponies, and one Arab. The stables were pucca built and the best in that part of Burmah, being situated on high ground in an open compound, seven and a half acres in extent, and surrounded by a stone wall. The grass supplied to the animals was specially brought in from high ground some five miles distant, whence it had been procured for some years past. The water was obtained from a pucca well in the compound. The grain, "crushed food," was the same as that supplied to most stables in the station and procured from Calcutta.

The stable containing the Burmans and Arab were situated on the south side of the paddock, while the Country-Breds were kept in a stable on the north side and in close proximity to the adjoining compound, only a road intervening. Eight animals died or had to be destroyed within 14 days on account of having contracted Surra, and veterinary surgeons and owner were non-plused as to how the animals could possibly have contracted the disease. Just at that time a break occurred in the rains and as always happens under such circumstances, flies were very numerous and aggressive. A few days later it came to notice that a pony was ill in the adjoining compound and on microscopical examination of its blood the Surra hæmatozoon was found teeming. This animal received green grass as fodder, from anywhere the grass-cutter could most easily obtain it. As all the animals, with the exception of the Arab, were allowed to run free in the compound, it is therefore more than probable that flies were the means by which the contagium of Surra was carried.

This outbreak only tends to emphasise the importance of recognising Surra at the first possible moment, in order that the subjects may be destroyed forthwith, and so do away with a focus for the dissemination of the disease by flies.

Table XIV.

Showing certain details concerning the mules destroyed in Mandalay on account of Surra together with the pathological changes found in the stomach, and the weight of the principal organs in each case.

No.	Description.	Size.	Condition.	Date of Admission.	Temperature.	Hæmatozoa.	Date of Destruction.	State of Stomach.	Lungs.	Heart.	Liver.	Spleen.	Kidneys.	Remarks.
					°F.					Lbs. oz.	Lbs. oz.	Lbs. oz.	Lbs. oz.	
422	Brown gelding.	Moderate.	Fair ...	21st July 1896.	105	S.	23th July 1896.	Extensive ulceration of cuticular coat.	Healthy.	2 7	8 0	2 15	1 7	No œdema or urticaria.
22	Bay mare ..	Do. ..	Do. ..	19th do.	103	S.	Do. ..	Extensive ulceration of cuticular portion.	..	2 12	8 12	2 8	1 1	Do. do.
132	Brown mare.	Do. ..	Very poor.	23rd do.	101	F.	Do. ...	Marked ulceration, almost perforation at one spot. No pigmentation.	..	2 13	6 15	3 7	0 15	Spiroptera micros. Many bots in stomach and duodenum.
880	Bay gelding.	Small ..	Do. ..	19th do.	101	S.	Do. ...	Marked ulceration, slight pigmentation.	..	2 9	8 0	2 6	0 13	Spiroptera micros. Parasites in intestines. Liver calcareous deposits atheroma of aorta.
235	Dark brown mare.	Do. ..	Fat ..	21st do.	102	S.	Do. ..	One large ulcer ½″×½″, many other smaller.	...	2 10	8 12	3 4	1 8	Gelatinous accumulation in furrows. No œdema or urticaria. Kidneys much enlarged and congested.
1220	Bay gelding.	Do. ..	Moderate..	20th do.	102	S.	Do. ..	Ulceration slight ..	..	2 2	7 10	2 4	0 10	Œdema of sheath. Old perihepatitis.
102	Do. ..	Moderate..	Fair ..	21st do.	102	S.	Do. ..	Do. ..	..	2 11	6 6	2 6	0 10	Slight œdema of limbs, no urticaria.
243	Dark brown gelding.	Do. ..	Poor ..	18th do.	102·4	N.	Do. ..	Ulceration slight, circular patches on villous coat.	..	3 0	7 6	2 4	0 12	Lachrymation, no œdema or urticaria.
1135	Brown mare.	Do. ..	Very poor.	25th do.	100·2	N.	Do. ..	Slight ulceration at one point on to villous coat.	..	3 0	6 8	1 12	1 3	Small abscess in substance of left lung. Sub-endocardial ecchymoses.
814	Dark brown mare.	Do. ..	Do. ..	22nd do.	100·2	S.	Do. ..	External ulceration, M. M. villous portion denuded in places.	..	3 0	6 0	1 8	0 8	Lungs consolidated into lobular deposition of jelly-like contagious Pleuro Pneumonia. Liver calcareous nodules.
G-200	Do. ..	Very large.	Emaciated.	24th do.	101·3	F.	Do. ..	Ulcerated pigment much erosive.	Healthy.	4 9	10 8	3 10	1 4	Œdema of lungs.
348	Chestnut mare.	Moderate..	Very poor.	23rd do.	101	S.	Do. ..	Marked ulceration. Circular patches on villous coat.	Do. ..	3 8	7 8	1 8	0 6	Spiroptera mieros., also few bots.
G-23-4	Bay gelding.	Do. ..	Do. ..	23rd do.	104	N.	Do. ..	Extensive ulceration.	Do. ..	3 8	9 8	2 8	1 9	Lachrymation profuse, no œdema or urticaria. Atheroma of aorta. Liver very hard. Kidneys large, pale and soft.
185	Bay mare ...	Do. ..	Poor ..	25th do.	102	S.	Do. ..	Extensive ulceration extending on to villous portion.	Do. ..	3 7	7 12	3 0	1 4	Spiroptera micros. and few bots.
66	Chestnut gelding.	Very small.	Do. ..	20th do.	102	S.	Do. ..	Extensive ulceration along border.	Do. ..	2 7	6 0	1 8	0 12	M. M. villous portion denuded in parts.
33	Brown mare.	Small ..	Do. .	19th do.	100·3	F.	Do. ..	Ulceration present.	Do. ..	2 13	7 15	3 2	0 14	No œdema, no urticaria.
398	Brown gelding.	....	Emaciated.	21st do.	101·3	N.	Do. ..	Slight ulceration on cuticular coat.	Do. ...	2 9	8 15	3 0	1 0	Do. do.
274	Do. ..	.. ..	Fair ..	9th do.	101·0	F.	5th Aug. 1896.	Slight ulceration, marked erosion, slight pigmented.	Do. ...	3 8	6 0	2 0	0 12	Lachrymation, slight œdema hind limbs and sheath.
40	Dark mare ..	Fair size ..	Poor ..	19th do.	102·2	S.	Do. ..	Slight ulceration..	Diseased.	3 6	8 6	3 2	1 0.	Lychrymation, slight œdema of hind limbs. Lungs seat of consolidation, &c., as in No. 40.
273	Brown gelding.	Moderate..	Fair ..	21st do.	102	S.	Do. ..	Well marked ulceration, thick lining of coats of organ.	Healthy.	4 6	8 14	2 4	1 9	Endocarditis. Kidneys large, very pale and œdematous.
G-33	Brown mare.	Small ..	Moderate..	20th do.	101	N.	Do. ..	Slight ulceration ..	Do. ..	2 5	6 0	2 9	0 11	No œdema, no urticaria.
669	Brown gelding.	Do. ..	Poor ..	21st do.	105	S.	Do. ..	Do. ..	Do. ..	2 15	7 6	4 2	1 6	Sub-endocardial ecchymoses, kidneys pals and œdematous.
513	Do. ..	Do. ..	Emaciated.	19th do.	100·3	F.	Do. ..	Marked ulceration.	Do. ..	2 5	5 3	2 0	0 10	Liver presents sign of old perihepatitis.
57	Brown mare.	Do. ..	Do. ..	20th do.	101	S.	D .. Dieo.	Extensive ulceration, spiroptera micros.	Diseased.	3 4	10 8	1 15	0 11	Consolidation, inferior portions of both lungs.
113	Brown gelding.	Do. ..	Do. ..	19th do.	101·4	F.	5th Aug. 1896.	Ulceration present.	Healthy.	3 12	8 11	2 12	1 7	Sub-endocardial ecchymoses. No œdema.

Manipur.

Lieutenant R. B. Berkley informed me that during the rains of 1890 the 44th Goorkha Regiment was quartered in Manipur territory. The transport for regimental purposes consisted of about 200 ponies obtained from Meerut and the Punjáb, varying between 13-2 and 14 hands, some 30 small but hardy Manipur ponies from 10 to 12 hands for ambulance purposes and 22 elephants.

In Manipur, at an elevation of 2,800 feet, the rains commenced about the middle of May. The stables in Lang-Thobal were long open sheds placed on a high embankment so as to raise the buildings above the marshy ground below. The grass obtained from the low ground was 2 to 3 feet long, with a thin round blade, and was considered coarse and poor. The water was collected in a tank from a stream, which ran into a small river some two or three hundred yards away. The *corn*, paddy (rice in the husk) was stored about 100 yards from the stables; number of rats frequented the godowns, but no bandicoots were observed. The disease broke out amongst the ponies in July; the chief symptoms noted were fever, ravenous appetite, eyes blood-shot, yellow coloured membranes, gradual loss of flesh; but, although the animals became thinner and thinner, they always ate all the fodder and corn given to them.

Eighty animals succumbed to Surra in all, but these consisted entirely of the north-country animals, the Manipur ponies remaining in perfect health.

Lieutenant Berkley took up with him to Manipur a 'Turkoman' gelding, 4 years of age. From the time of its purchase in Calcutta at the beginning of June 1890, during its seven month's residence in Manipur and eighteen months in Shillong (Assam) the animal was perfectly fit. Its rations consisted of paddy and Muthi-Kalai, 3 pounds, Kala-Nammik (sulphur and salt ½ ounce of each) mixed with the corn.

This animal stabled by itself and was never allowed to go near to the transport lines.

The syces in attendance on the transport animals during the time they resided at Mnipur suffered more or less continuously from intermittent fever and occasionally dysentery.

Naga Hills.

*Kay-Lees,** in December 1881, was ordered to proceed to the Naga Hills, to investigate a disease which had broken out amongst the transport animals. The Naga Hills are situated to the north-east of Assam, and Kohima forms the furthermost post on the north-east frontier of India. Nichuguard, the head transport office on the line of communication, lay some seven days' march through dense jungle. The author states "the jungle was so dense and enclosed at some parts that, combined with the gases given off from decaying vegetable matter, it interfered with free respiration." "The rains commenced about the 15th March and continued until the middle of June, during which time extensive inundations took place, converting large tracts into swamps. The climate was hot and moist, and at least 25 per cent. of the establishment were down with fever, dysentery" &c. "The disease appears to have been most fatal amongst the mules and ponies between March and June.†" There was no proof of what the actual disease was, as all the animals at work the previous season were dead. Kay Lees found that "if a wound or abrasion of the epidemic of any kind occurred after the 15th March, it was almost impossible to cure it, owing to the part becoming fly-blown and afterwards filled with maggots, or ulceration setting in of a malignant nature."

The main mortality however "was brought about by the attacks of the *Tsetse fly*. As this fly does not appear to have been previously observed in India, I especially wish to bring it to notice, and will endeavour to give a brief description of it. This insect is about the size of a common house-fly, but of a dark-brown colour. The after-part of the body has always three, and very often four, yellow bars across it.

These marks or bars are very characteristic. The proboscis is divided into three portions, the middle one being the longest, and projects in a straight line from the head. When on the wing, the fly gives a very peculiar buzz, which would cause most people instinctively to evade it. It is "remarkably alert." The author had the opportunity of seeing this fly several times in the jungle a few miles from Nichuguard, and when he found that nearly all the ponies and mules had died of debility or a gradual wasting away of the body, he naturally associated the fly with the disease. The symptoms noted in equines were: "a gradual but persistent wasting of the animals affected; in fact they became so emaciated that one might be readily led to suppose that they were dying from starvation. They appear to have been bitten by an insect, as on one or more places of the body there is itchiness, which is followed by the formation of an ulcerating sore of a malignant character. But one peculiarity of the ulcer is that it has but little tendency to spread or to heal. The ulcers are about one inch in diameter, and occur on the fetlocks, knees, shoulders, hips, &c. Swellings occur between the fore arms and extend along the floor of the abdomen, visible mucous membranes have the diagnostic paleness of anæmia. Occasionally there is a muco-purulent discharge from the eyes and nose. Muscular atrophy is more or less rapid, but one circumstance which I particularly noticed was that animals in a plethoric condition much more rapidly succumbed than those in an opposite state of health. Comparing the above symptoms with those described in Dr. Livingstone's work, and having personally seen the insect, I have not the slightest hesitation in attributing the mortality amongst the transport animals on the Naga Hills to the Tsetse fly."

It appears that mules and ponies which worked well in the plains and were in good condition, when removed to Nichuguard, never did a day's work, but died of debility. The mortality was greatest during and shortly after the rains, and the *glossina morsitans* was most prevalent at this period. The transport animals were picketted in the open, therefore the fly had every advantage of being able to get at its victims. "*No cases, so far as I could learn after the fullest enquiry, had ever been known to recover.*"‡

"Horses were found to be most susceptible to the poison of the fly; this was so well known that officers would take horses of no value to these hills when stationed there, as it was a well known fact that they never lived more than two or three seasons."

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* Kay-Lees, F. R. C. V. S., Army Veterinary Department:
"The Glossina morsitans or Tsetse fly."—*The Veterinary Journal*, 1888, page 79.

† The rains commence much earlier than in India.

‡ This is not in Italics in the original.

Kay Lees evidently did not examine the blood of these animals, for he states, after giving the fullest details with regard to the symptoms of Surra: "I was unable to trace any history of Anthrax, Surra or Bursati, &c., which could account for this mortality."

The suggestions which this officer made with a view to stopping the disease were acted upon, and two years later had the effect of "almost entirely eradicating the pest."

The chief suggestions were as follows:—

(i) Entire removal of all transport animals during the season when the Glossina morsitans was most prevalent, to Golaghat on the plains.

(ii) Coolie labour to be utilized in place of transport animals during the rains, &c.

(iii) Increased diet of a nutritious nature to the animals.

(iv) Increased establishment including syces, grass-cutters and salootries.

TABLE XV.

Showing the total recorded mortality from Surra in equines each month, during the years 1890—1897.

Localities.	January.	February.	March.	April.	May.	June.	July.	August.	Septem. ber.	October.	Novem- ber.	Decem- ber.	Total.	Remarks.
Punjáb	74	88	46	21	33	42	203	549	227	504	236	210	2,323	These figures are based on the returns received showing the date of outbreak and the number of animals died. There were many other outbreaks, with a loss of thousands of animals, but without detailed information.
Rajputana	45	...	...	...	...	...	...	...	...	22	197	90	354	
North-West Provinces	79	45	...	...	...	1	36	72	433	671	512	104	1,953	
Jabalpur	3	5	...	...	...	...	...	...	...	5	6	4	23	
Bombay	6	1	...	...	2	...	2	7	30	43	38	23	157	
Burmah	12	7	1	5	6	46	437	143	154	139	84	34	1,068	
Manipur	...	...	...	...	...	..	80	...	...	...	...	...	80	
Total ...	219	146	47	26	41	89	758	771	844	1,384	1,163	470	5,958	

TABLE XVI.

Showing the total recorded mortality from Surra in camels each month, during the years 1890—1897.

Localities.	January.	February.	March.	April.	May.	June.	July.	August	Septem- ber.	October.	Novem- ber.	Decem- ber.	Total.	Remarks.
Punjáb	3	3	2	...	...	...	53	10	5	36	...	...	112	
Rajputana	28	11	22	24	39	28	36	28	32	24	39	21	332	In addition to these, 410 camels died belonging to Ganga Risala.
North-West Provinces	...	...	...	...	...	...	50	70	310	128	52	...	430	
Total ...	31	14	24	24	39	28	139	108	167	188	91	21	874	

B.—In other countries.

*Algeria.**

Africa.—A propos of the observation of Dr. Legrain of Bougie, on the *Trypanosoma* of Bovines, Mons. J. Chauvrat records the discovery of a hæmatozoon in the blood of a Barb horse which died of anæmia some years ago. The history of the case was as follows.

Entire horse (Cascari) age 9 years, belonging to a Sowar (Sepahi), a Sheik, in the neighbourhood of Barika, arrived at Batna on the 19th November 1892 after four days' march. The animal was sent to the hospital on account of the deplorable condition it presented. After days of suffering it became a mere walking skeleton; when moving, the body swayed to and fro; the extremities and under-surface of the abdomen were infiltrated. Every symptom pointed to the extreme debility of the animal, which was in the last stage of anæmia, sunken eyes, paralysis of the lower lip, anus gaping, minor membranes absolutely blanched. Respiration short and interrupted—21 to the minute, temperature 38·3° C. Pulse feeble, rapid, thready—92. Pulsations of the heart forcible and audible. Dimunition of the respiratory murmur in the inferior portion of both lungs, also a little dullness on percussion. Appetite poor, animal only nibbles its food. The predominating character of the ailment was anæmia, accompanied with pulmonary complications.

20th November.—Temperature A.M. 37·8° C., P.M. 38·6° C.

21st.—No notable change in the animal's condition.

22nd.—Animal's condition unchanged. Morning remissions and evening exacerbations of the temperature.

24th.—Complete loss of appetite, extreme feebleness. Pulse 104. Temperature 39·2°C. Pulsations noticeably increased. During the evening the animal fell.

25th.—Unsuccessful attempts made to place the animal on its legs. Death took place in the evening.

* Chauvrat, J,—
Vétérinaire en 1er au 3e spahis.
"Un cas d'anémie pernicieuse du cheval en Algérie causée par un Trypanosome."
VIII Série— Tome III—No. 11, page 344.

Autopsy.—Immediately after death. The body resembles a skeleton ; œdema of limbs and under-surface of abdomen. *Abdominal Cavity.—Intestines* very pale, but little change noticeable. *Mesentery* infiltrated and yellow in colour. *Stomach* healthy, contains a quantity of undigested food. *Liver* and *spleen* present a normal appearance ; muscles paler than normal, and not the least trace of adipose tissue present. *Thoracic Cavity.*—Four litres of a lemon-coloured fluid, almost transparent. The inferior portion of the lungs and especially near the apex are the seat of consolidation, yellowish-white in colour in places and red in others. A limited adhesion of the anterior lobe of the left lung to the costal pleura exists. At the most dependent parts of the pleural sacs, yellow-coloured false membranes cover the costal pleura and anterior mediastinum. Lesions of chronic pleuro-pneumonia. *On section* consolidated areas of the pulmonary parenchyma, discoloured, presenting the yellow tint of a dead leaf. *Pericardium* intact. *Heart* normal in size. *On section* tissues friable and cavities contain red but no white clot. The blood, yellowish-red in colour, considerably reduced in quantity, coagulates rapidly and the serum of a yellowish-brown colour quickly separates. On microscopical examination of the blood a large number of hæmatozoa are observed in active movement. From the aspect and rapid movements, the observer thinks, the organism much resembles the *Trypanosoma Evansi,* which causes Surra in India and Tonquin.

France.

In 1896, M. A. Dr. Legrain* discovered a hæmatozoon, belonging to the class of flagellate infusoria, Genus *Trypanosoma,* in the varicose dilitations developed on the external surface of the pericardium of a cow, killed at the abattoir at Bougie, France. This infusorian has not been brought to notice before in bovines in France.

The author remarks that the *Trypanosoma* does not sensibly differ from the parasites met with in fish, frogs, birds, rats, camels and horses, found in the last mentioned in India, Syria and in Egypt. The parasite in question is an organism formed of protoplasm furnished with a flagellum, a nucleus, and an undulating membrane and measures about 50μ. The carcass of the cow did not present any organic lesions, but emaciation and an anæmic condition were marked. The varicose dilitations resembling bunches of grapes alone attracted attention, but these can scarcely be attributed to the presence of the organism.

Abysinnia.

During the Abysinnian Campaign in 1867, the transport lost a large number of animals from a disease very much resembling Surra. Veterinary-Colonel I. H. B. Hallen, who was in charge of the transport animals, some years after his return to this country, recognised the likeness of the disease in India caused by the *Trypanosoma,* with that encountered by him in equines during the above campaign. During the march from the sea coast to the high ground of Magdala, strips of country were crossed where large numbers of flies (*Zimb*) attacked the animals and caused them much suffering.

German East Africa.

There is reason to suppose that the disease observed in German East Africa is analogous to that described by Bruce as Tse-tse fly disease or Nagana in Zululand. Professor R. Koch is at the present time engaged in the study of certain diseases in that region, and will no doubt have something to say with regard to the *Trypanosoma* found in the blood of animals in those parts.

Zambesi.

The following extract has been taken from Dr. Livingstone's Travels† in South Africa, as it gives as far as we know the first and best account of the ravages of the Tse-tse fly :—

> "We had come through another Tse-tse district by night, and at once passed our cattle over to the northern bank to preserve them from its ravages.
>
> "A few remarks on the Tse-tse, or *Glossina morsitans,* may here be appropriate. It is not much larger than the common house-fly, and is nearly of the same brown colour as the common honey-bee ; the after-part of the body has three or four yellow bars across it ; the wings project beyond this part considerably, and it is remarkably alert, avoiding most dexterously all attempts to capture it with the hand, at common temperatures ; in the cool of the mornings and evenings it is less agile. Its peculiar buzz when once heard can never be forgotten by the traveller whose means of locomotion are domestic animals ; for it is well known that the bite of this poisonous insect is certain death to the ox, horse and dog. In this journey, though we were not aware of any great number having at any time alighted on our cattle, we lost forty-three

* "Trypanosome des Bovides." Re Le Progres Veterinaire, No. 11. 15 Mars 1896, also Recueil Veterinaire, VIII Série, Tome III, No. 7.

† Missionary Travels and Researches in South Africa by David Livingstone, LL.D., D.C. L., 1st Edition, published in 1857, pages 80—83.

fine oxen by its bite. We watched the animals carefully, and believe that not a score of flies were ever upon them.

"A most remarkable feature in the bite of the Tse-tse is its perfect harmlessness in man and wild animals, and even calves so long as they continue to suck the cows. We never experienced the slightest injury from them ourselves, personally, although we lived two months in their *habitat*, which was in this case as sharply defined as in many others, for the south bank of the Chobe was infested by them, and the northern bank, where our cattle were placed, only fifty yards distant, contained not a single specimen. This was the more remarkable, as we often saw natives carrying over raw meat to the opposite bank with many Tse-tse settled upon it.

"The poison does not seem to be injected by a sting, or by ova placed beneath the skin, for, when one is allowed to feed freely on the hand, it is seen to insert the middle prong of three portions, into which the proboscis divides, somewhat deeply into the true skin; it then draws it out a little way, and it assumes a crimson colour as the mandibles come into brisk operation. The previously shrunken belly swells out, and, if left undisturbed, the fly quietly departs when it is full. A light itching irritation follows, but not more than in the bite of a mosquito. In the ox this same bite produces no more immediate effects than in man. It does not startle him as the gad-fly does; but a few days afterwards the following symptoms supervene: the eye and nose begin to run, the coat stares as if the animal were cold, a swelling appears under the jaw, and sometimes at the navel; and, though the animal continues to graze, emaciation commences, accompanied with a peculiar flaccidity of the muscles, and this proceeds unchecked until, perhaps months afterwards, purging comes on, and the animal, no longer able to graze, perishes in a state of extreme exhaustion. Those which are in good condition often perish soon after the bite is inflicted with staggering and blindness, as if the brain were affected by it. Sudden changes of temperature produced by falls of rain seem to hasten the progress of the complaint; but in general the emaciation goes on uninterruptedly for months, and, do what we will, the poor animals perish miserably.

"When opened, the cellular tissue on the surface of the body beneath the skin is seen to be injected with air, as if a quantity of soap-bubbles were scattered over it, or a dishonest awkward butcher had been trying to make it look fat. The fat is of a greenish-yellow colour and of an oily consistence. All the muscles are flabby, and the heart often so soft that the fingers may be made to meet through it. The lungs and liver partake of disease. The stomach and bowels are pale and empty, and the gall-bladder is distended with bile.

"These symptoms seem to indicate, what is probably the case, a poison in the blood; the germ of which enters when the proboscis is inserted to draw blood. The poison-germ, contained in a bulb at the root of the proboscis, seems capable, although very minute in quantity, of reproducing itself, for the blood after death by Tse-tse is very small in quantity, and scarcely stains the hands in dissection. I shall have by and by to mention another insect, which by the same operation produces in the human subject both vomiting and purging.

"The mule, ass and goat enjoy the same immunity from the Tse-tse as man and the game. Many large tribes on the Zambesi can keep no domestic animals except the goat, in consequence of the scourge existing in their country. Our children were frequently bitten, yet suffered no harm; and we saw around us numbers of zebras, buffaloes, pigs, pallahs and other antelopes feeding quietly in the very habitat of the Tse-tse, yet as undisturbed by its bite as oxen are when they first receive the fatal poison. There is not so much difference in the natures of the horse and zebra, the buffaloe and ox, the sheep and antelope, as to afford any satisfactory explanation of the phenomenon. Is a man not as much a domestic animal as a dog? The curious feature in the case, that dogs perish though fed on milk, whereas the calves escape so long as they continue sucking, made us imagine that the mischief might be produced by some plant in the locality, and not by Tse-tse; but Major Vardon, of the Madras Army, settled that point by riding a horse up to a small hill infested by the insect without allowing him time to graze, and, though he only remained long enough to take a view of the country and catch some specimens of Tse-tse on the animal, in ten days afterwards the horse was dead.

"The well-known disgust which the Tse-tse shows to animal exerta, as exhibited when a village is placed in its habitat, has been observed and turned to account by some of the doctors. They mix droppings of animals, human milk, and some medicines together, and smear the animals that are about to pass through a Tse-tse district, but this, though it proves a preventive at the time, is not permanent. There is no cure yet known for the disease. A careless herdsman, allowing a large number of cattle to wander into a Tse-tse district, loses all except the calves; and Sebituane once lost nearly the entire cattle of his tribe—very many thousands—by unwittingly coming under its influence. Inoculation does not insure immunity, as animals which have been slightly bitten in one year may perish by a greater number of bites in the next; but it is probable that with the increase of guns, the game will perish, as has happened in the South, and the Tse-tse, deprived of food, may become extinct simultaneously with the larger animals."

Zululand.

Tse-tse Fly disease or Nagana.—Surgeon-Major D. Bruce, A. M. S., in a preliminary report published in December 1895, defines the disease as " a specific one, which occurs in the horse, donkey, ox and dog and varies in duration from a few days or weeks to many months. It is invariably fatal in the horse, donkey and dog, but a small percentage of cattle recover. It is characterized by fever, infiltration of coaguable lymph into the subcutaneous tissue of the neck, abdomen or extremities, giving rise to swelling in these regions, by a more or less rapid destruction of the red blood corpuscles, extreme imaciation, and the constant occurrence in the blood of an infusorial parasite, either identical with or closely resembling the *Trypanosoma Evansi* found in Surra, a disease of India and Burmah. *On post-mortem* examination, deposition of a yellow jelly-like material in the subcutaneous tissue, inter-muscular layers and under the serous covering of the heart, with purplish stains or ecchymosis in various regions as on the inner aspect of the skin, the serous membrane covering the lungs, and the outer and inner surfaces of the heart, enlargement and softening of the spleen and congestion and fatty degeneration of the various organs."

Distribution in Zululand.—" Broadly it may be stated that the disease is limited to certain tracts, the physical conditions of which imply heat and moisture. These tracts in Zululand are situated in the level coast plain, which extends some 50 miles inland, and river valleys which enter or debouch on this plain. From Ubombo, situated on the summit of one of the hills forming the chain of the Lebombo mountains, a good view is obtained of this level coast plain, stretching from the base of the mountain to the sea, some 60 miles off. It looks as level as a billiard table, and is covered as far as the eye can reach to the north and south and merges in the blue of distance and of the sea to the eastward. A few miles to the south, the river Imkasi can be seen winding across the plain, having just passed through the Lebombo Range by a deep canon or poort, to fall into St. Lucia Lake, its course being by the denser vegetation along its banks; and some dozen miles to the north, another river, the Pongola, runs out into the plain in the same manner, to turn northward to Delagoa Bay. The strip of country opposite, lying between the two rivers and extending some 15 miles out, is 'fly country' the home of Nagana and malaria and uninhabited except by wild animals."

" The evidence goes to show that the disease has existed in the lower tracts of the country, time out of date, and is in no sense a new disease."

The first series of experiments instituted was, to find if flies kept in captivity at Ubombo would cause any local or general disease in susceptible animals. Result negative. The next series was devised in order to prove whether the Tse-tse fly can or cannot carry the disease from an affected animal to a healthy one. Result positive. A healthy horse was taken on three days (19th. 24th, and 29th September) into the fly-country, and remained there without being allowed to graze from 10 A.M. to 4 P.M. It was noted that Tse-tse flies settled on him during the day. On October 4th on microscopical examination of his blood he was found to be suffering from the fly disease.

That this parasite is the true cause of fly-disease is rendered almost certain from the following considerations.

1. It is found in the blood of every animal suffering from this disease, and is absent from the blood of all healthy horses, cattle or dogs.

2. The onset of the disease is marked by a rise of temperature, and this corresponds with the first appearance of the hæmatozoa in the blood.

3. As the disease progresses *pari passu* with the destruction of the red blood corpuscles, the parasites tend to become more numerous, sometimes reaching the enormous number of 6, 10, 15, millions in every drop of blood.

4. The transference of the smallest quantity of blood from an affected to a healthy animal sets up the disease in the latter, as even the very small quantity of blood conveyed by the proboscis of a few tse-tse flies is sufficient to carry the disease from animal to animal.

The disease in cattle 'may be of a much slower and more chronic nature than in the horse or the dog.' Cattle " gradually waste away, the hair at first harsh and staring tends to fall off, there is the same trickling of a watery fluid from the eyes and nose and a tendency to diarrhœa. In many cases the dewlap becomes swollen and boggy, but I have not found the same tendency to the swelling of the under-surface of the belly or the extremities as in other animals, nor have I even seen blindness occur in cattle. The hæmatozoa are also in my experience much less numerous in the blood of cattle than in that of horses and dogs, and often require to be looked for on several days in succession before they can be demonstrated."

In cattle, therefore, it would be rash to affirm that the disease from which they were suffering was not Nagana until the blood had been subjected to daily microscopical examination for at least a week.

Tonquin (Cochin-China).

Blanchard * observed Surra amongst the mules imported into Tonquin (Cochin-China) for the use of the French Army.

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* *Blanchard.* " Etude sur une Maladie Spéciale des Mulets Importés au Tonkin."
Bulletin, Soc. Centr. de Méd Veterinaire, 1888, page 694.

M. Mollereau * also observed the same disease amongst mules in Tonquin.

Korea (China)

W. G. Campbell† says : " In the forest regions of Korea, insect pests abound in the summer months. Musquitoes, gnats, and gadflies make the lives of the settlers perfectly burdensome for two or three months of the year, and *ponies* and bulls quickly succumb to their attacks. The houses are kept constantly filled with birch-smoke to drive them off; cattle are protected by fires of green wood in the open ; and men working the clearings carry coils of rope made from dry *artemesia*, which burns slowly and emits a pungent odour for the same purpose."

SECTION IV.

PRECIS OF HORSE SURRA CASES.

(i).—Naturally acquired Surra.

CIV.—A New-Zealand Mare, aged 11 years, was purchased by the Bombay Tramway Company in March 1888 and has since done excellent work. On August 9th, 1894, as she was looking thin and out of sorts she was relieved from work. August 11th, animal was suffering from fever, Temperature 40·4 °C., Pulse 72. On microscopical examination of the blood, numerous Surra organisms were discovered. The mare arrived at the Laboratory stables, Poona, on the morning of the 13th August 1894, and on the following evening during a paroxysm was submitted to a treatment consisting of Liquor Arsenicalis in gradually increasing doses commencing with grains iv. On the morning of the 18th August, after 36 grains of Arsenic had been administered, the hæmatozoon was found to have disappeared from the blood, and remained absent until the time of death which occurred on the 17th September, a period of 31 days. The animal received 225 grains of Arsenic between the 14th August and the morning of the 5th September, after which date only 11 grains were taken, owing to symptoms of gastric irritation. During the whole period that the animal was under observation, the temperature remained high, oscillating between 38 °C. (100·4 °F.) and 40·8 °C. (105·4 °F.), but on the day of death recorded 41·3 °C. (106·3 °F.).

Autopsy.—Body well nourished, entire absence of œdema from extremities and under-surface of abdomen. *Thorax.*—No adhesion of the pleuræ, but each cavity contains several (10) ounces of a turbid orange-coloured fluid. *Trachea* contains frothy mucus, mucous membrane lower one-third congested. *Lungs*,—*Right* healthy, *Left* small, sub-pleural extravasations of blood. Anterior lobe consolidated, individual lobules insulated by a thin layer of exudation. *Pericardium.*—The sac contains a small quantity of a turbid, orange-coloured fluid. *Heart* weighs 6 lbs. 8 ozs. External surface presents healthy appearance. *Right Auricle* ditto, *Right Ventricle* sub-endocardial petechiæ. *Left Auricle* and *Ventricle* ditto. *Valves* healthy. *Abdominal Cavity* contains 60 ounces of orange-coloured fluid. *Liver* weighs 13 lbs. 12 ozs. Old perihepatitis ; *on section*, tissues dark in colour, friable. *Spleen* 4 lbs. 2 ozs. Surface of organ petechiated, *on section* tissues firm, &c. *Kidneys.*—Right 2 lbs., left 2 lbs. 2 ozs. Capsules strip easily, surfaces of organs petechiated *On section* Malphigian corpuscles prominent and bright-red in colour. *Stomach* small. *On section* contains semi-fluid food, yellow in colour. *Cuticular* portion healthy, mucous membrane covering *villous* portion congested, dotted over with small circular patches, majority red, remainder almost black in colour, due to small extravasations of blood in and beneath the inner coat of the organ. *Small intestines.*—There are small dark-coloured patches, and extravasations into the sub-mucous tissues throughout its whole length. *Large intestine* apparently healthy. *Bladder.*—Mucous membrane congested, but not petechiated.

No. CVI.—Country-Bred Entire horse, aged, belonging to a private gentleman, was received from Bombay on the 7th September 1894. The animal had been suffering from fever for 20 to 25 days, and had been under treatment during the 12 days previous to its admission at the Laboratory stables. *On admission* the horse was in fair condition but weak. The usual symptoms of fever were present. The visible mucous membranes were tinged a yellow colour, conjunctivæ petechiated. Temperature 38·9° C. Pulse 57. Respirations 48. Appetite fairly good. Dung presented a normal appearance. The blood contained a few hæmatozoa. Arsenic was administered in small doses. At 5 A.M. on September 9th, the animal fell in the stable, and death took place at 6-30 A.M.

Autopsy.—Body well nourished. Some swelling and œdema of the lower extremities. *Thorax.*—About 19 ozs. of a yellow-coloured fluid in the pleural cavities. *Lungs* œdematous, surfaces present several sub-pleural extravasations. *Pericardium.*—The sac contains some ounces of yellow-coloured fluid. *Heart* 8 lbs. 10 ozs. Very much enlarged, dilatation with hypertrophy. *On section*, Right and Left Ventricles some few sub-endocardial extravasations. *Abdominal Cavity* contains several pints of fluid. *Liver* 10 lbs. 4½ ozs. Old perihepatitis, no calcareous nodules. *On section* tissues dark in colour, *Spleen* 2 lbs. 3 ozs. Tissues firm. *Kidneys.*—Right 1 lb. 11 ozs. Left 1 lb. 9½ ounces. *Stomach* distended, *on section* contains semi-solid food. *Cuticular* and *villous* portions present a healthy appearance. *Intestines* ditto. *Bladder* ditto.

* *Mollereau* ' Sur une maladie des Mulets an Tonkin.'
Bullet. Soc. Centr. de Med Veterinaire, 1888, page 694.

† A journey through North Korea to the Chăng-pia-Shan.—*Journal Royal Geographical Society*, March 1892, page 155.

No. CVII.—Australian Gelding, aged 14 years, No. 536, belonging to the Bombay Tramway Company. Animal first noticed to be ailing 23rd September 1894. Surra hæmatozoon discovered in blood on the same date. The horse arrived at the Laboratory stables on September 25th, and the same evening was placed on Arsenic (grs. iv) in the form of Liquor Arsenicalis. Fifty-two grains in all were given; the chemical had to be discontinued on account of symptoms of gastric irritation supervening. The temperature varied between 38·3 °C. (100·9 °F.) and 40·2°C. (104·3 °F.) and rose at the time of death which occurred on October 4th to 40·3°C. (104·5 °F).

Autopsy.—Body somewhat emaciated. Absence of œdema. *Thorax.*—Several ounces of a semi-turbid fluid in the pleural cavities, no pleural adhesions. *Lungs.*—Localized emphysema of the outer lobes and free borders, and sub-pleural ecchymoses dotted over the surfaces of both organs. There is consolidation of the posterior third of the left lung. *On section* the consolidated portion presents a dark appearance, and the individual lobules are separated from each other by a layer of orange-coloured jelly. The remaining portions of the organs are distended with air. *Pericardium*—The sac contains several ounces of a semi-turbid fluid. *Heart*, considerably hypertrophied, weighs 7 lbs. 13 ozs. *Externally* extensive dark-red coloured extravasation lying under the epicardium, and involving the right ventricle, a second over the apex of the left ventricle. *On section.*— *Right Auricle* and *Ventricle* walls thin and placid, contain black clots of blood. *Left Ventricle* contracted, walls hypertrophied. *Left Auricle* healthy. A few ecchymoses involving the bases of the musculi-papillaris, and the flaps of the valves. *Abdominal* cavity contains 20 ozs. of slightly turbid fluid, *Liver* weighs 22 lbs. ½oz. nearly double natural size. Opalescent patches involving Glisson's capsule. *On section* certain amount of blood exudes from cut ends of the vessels. Tissues dark in colour and firm. *Spleen* 3 lbs. 6 ozs. nearly double normal size. Surfaces petechiated. Tissues firm. *Kidneys* enormously enlarged. Right weighs 3 lbs. 3 ozs., the Left 3 lbs. 9 ozs. Capsules strip easily. Surfaces of both organs thickly petechiated. *On section* cortical portion thicker than normal, Malphigian corpuscles stand out well marked. *Stomach* distended. *On section, Cuticular* portion healthy, there is a patch of congestion, involving the mucous membrane of the villous portion near the pylorus. *Small intestine* petechiated. marked congestion of the mucous membrane throughout. *Large intestine* healthy. *Bladder* ditto.

No. CVIII.—An Arab Entire horse, aged, forwarded for treatment by Messrs. Scott and Company, Bombay. Previous history not obtained. The animal arrived at the Laboratory stables on the morning of 25th September 1894, in poor condition, evidently suffering from Surra for a considerable time, on the following day slight general urticaria was observed, and all the marked symptoms of the disease, in addition sphincter ani relaxed and rectum patent. On the morning of the 27th September the animal was subjected to a treatment consisting of Liquor Arsenicalis (grs. iv) in gradually increasing doses, later the dose to be altered according to the condition of the patient. After 20 grains of Arsenic had been administered the hæmatozoon disappeared from the blood, and up to the time of death on November 20th, a period of 53 days, had not returned. In all 370 grains of the chemical were given. The temperature varied between 36·6 °C. (97·9 °F) and 40·5° C. (104·9 °F.). When the animal fell, chloroform was administered and death took place a few minutes later.

Autopsy.—Body well nourished, some œdema of the extremities. *Thorax.*—No pleural adhesions. Cavities each contain about one ounce of an orange-coloured fluid. Right lung distended with air, one large, dark-coloured extravasation 2″×2·5″ lying beneath the visceral pleura, *on section* blood found to invade the tissues to a depth of one inch. Left lung healthy. *Pericardium.*—The sac contains 10 ozs. of a semi-turbid orange-coloured fluid. *Heart* small, weighs 2 lbs. 0¾ oz., organ healthy. *Kidneys.*—Right weighs 1 lb. 8 ozs., left 1 lb. 6 ozs. Tissues healthy. *Stomach* small. *On section, cuticular* portion healthy. *Villous* portion, mucous membrane presents red lines in streaks on its surface. *Intestines* healthy. *Bladder* ditto. *Brain* ditto.

No. CIX.—Persian-Gulf Entire, belonged to G. Division, Bombay Police. This animal was stationed at Mahím for months, fever observed October 7th, 1894. Removed to Parel Veterinary Hospital 11th October, where the hæmatozoon was discovered in its blood, remained there until November 4th, when it was sent to Poona. Received Laboratory Stables November 5th, 1894. Surra of one month's standing. On the evening of the 5th November the animal was subjected to a treatment consisting of Liq. Arsenicalis (Arsenic grs. iv) twice during the 24 hours, the dose to be gradually increased, and later diminished if necessary according to the condition of the patient. In addition Sulphate of Iron in 1 drachm doses was given mixed with the corn from the evening of the 3rd to the 26th December. Five hundred and sixty-one grains of Arsenic were administered between 5th November 1894 and the 5th January 1895. On the latter date the chemical had to be discontinued on account of symptoms of gastric irritation. The temperature varied between a maximum of 40·4 °C. (104·7°F.), and a minimum of 37·6 °C. (99·7 °F.), but at the time of death, January 15th, 1895, the 97th day of the disease it ran up from 39 °C. (102·2°F.) to 41·4°C. (106·5°F.).

Autopsy.—Body well nourished, no œdema of extremities. *Thorax.*—No fluid in or adhesions of the pleuræ. *Lungs.*—*Right* presents nothing abnormal, *Left*, seat of hypostatic congestion. *Pericardium.*—Small quantity of an amber-coloured fluid in the sac. *Heart* weighs 6 lbs. 12 ozs. *External* surface free from petechiæ. *On section, Right Auricle* and *Ventricle* contain fluid blood; *Left Auricle* healthy, Left Ventricle contracted, few sub-endocardial dotted over the bases of the *musculi papillaris*. *Abdominal* cavity free from fluid. *Liver* very large, 17 lbs, signs of old perihepatitis. The individual lobules are well marked, centre being dark, external zone light colour. *On section* much blood exudes from the cut ends of the vessels. *Spleen* large, 3 lbs. 8 ozs., sub-capsular petechiæ. Tissues tolerably

firm. *Kidneys.*—Right 2 lbs 3½ ozs., Left 2 lbs. 5 ozs., capsule strips easily, *on section* tissues deeply congested. Pyramidal tubes injected, Malphigian corpuscles deep red colour, clearly defined. *Stomach* healthy. *Large and Small Intestines* ditto. *Bladder* ditto.

No. CX.—Persian-Gulf Entire Horse, aged 9 years, belonging to the Bombay Mounted Police (No. 27) was purchased on the 24th September 1894, and kept in Bombay until November 4th. On the 27th October the animal was first observed to be ailing. In addition to corn, green grass was given as fodder from 1st to the 21st October. The animal was received at the Laboratory stables on November 5th, at 7 A.M. *On admission* the animal presented usual symptoms of fever, the mucous membranes are yellow in colour and petechiated, swelling and œdema of sheath, scrotum and under-surface of the abdomen. Temperature 40·5°C. Pulse 64. Respiration 44.

On the evening of its arrival the animal was put on Arsenic (grs. iv) in the form of Liquor Arsenicalis in gradually increasing doses. After 23 grains had been administered the hæmatozoon disappeared from the blood (November 8th), and between that date and death, which took place on December 21st, did not re-appear.

On the 24th and 25th days of the Intermission the temperature rose to 39·5°C., and it was thought likely that the organism would return, but on the following day (26th) it again fell to 38·°C. Between the date of admission and death, the animal's temperature oscillated between 41°C. (105°F.) and 37·8°C. (100·2°F). Three hundred and twenty-one grains of Arsenic were administered in all, but for nine days previous to death, the medicine was discontinued on account of bladder symptoms intervening.

Autopsy.—Body well nourished, no œdema or swelling of the limbs, &c.

Thorax.—No fluid present in the pleural cavities, but there are adhesions present, the result of an old pleurisy. *Lungs.—Right* healthy, *Left* seat of hypostatic congestion. *Pericardium*—the sac contains two drachms of an amber-coloured fluid. *Heart* weighs 4 lbs. 8 ozs., external surface of the organ petechiated especially bordering on the inter-ventricular sulie. *On section* the cavities present a healthy appearance. The valves are stained yellow in colour. *Spleen* 2 lbs. 4½ ozs. Tissues present healthy appearance. *Kidneys* weigh—Right 1 lb. 3¼ ozs., Left 1 lb. 4¼ ozs. Externally the organs present a mottled appearance *on section.* Malphigian corpuscles are of a dull red hue and stand out prominently. *Stomach.—Cuticular* portion presents one fairly large and four small ulcers near the line of demarcation, the mucous membrane of the villous portion is also congested. *Large* and *Small Intestines* ditto. *Bladder.*—The mucous membrane of bladder extensively ulcerated. Ulcers covered with urinary deposits resembling 'Fuller's earth.' Other portions dark red in colour.

No. CXI.—Persian-Gulf Entire Horse (No. 100), aged four years, belonging to the Bombay Mounted Police, was stationed in and around the city from the 16th June until the 17th October, on which date it was observed to be ailing. 20th October sent to Veterinary College, Parel, for treatment. An average of 20 lb. of green grass was given as fodder between the 1st September and 21st October 1894. The animal was received at the Laboratory stables on November 5th. *On admission.*—The visible mucous membranes present a faintly yellow appearance, and there is an accumulation of semi-solid œdema in front of the chest. Temperature 38·2°C. Pulse 48. Respiration 24. On the evening of its arrival the animal was put on Arsenic (grs. iv) in the form of Liquor Arsenicalis, in gradually increasing doses. After 43 grains of Arsenic had been administered the Surra hæmatozoon disappeared from the blood (October 10th), and between that date and death on the 26th of December, only one organism was observed, viz. December 8th. From the 26th to the 30th day of the intermission the temperature began to rise, until it attained on the latter day 40°C. (104°F.) and one hæmatozoon was seen in several specimens of blood. Between the date of admission and death the animal's temperature oscillated between 40·7°C. (105·2°F.) and 37·4°C. (99·3°F.). Four hundred and eight grains of Arsenic were administered in all, but the Arsenic was discontinued four days before death on account of gastric irritation.

Autopsy.—Body well nourished, no œdema of the extremities, &c.

Thorax.—No fluid in the pleural cavities or adhesion of the pleuræ. *Lungs,* slight emphysema of the anterior lobes, otherwise healthy. *Pericardium* contains few ounces of an orange-coloured fluid. *Heart* weighs 4 lbs. 11 ozs.; *external surface* dotted over with numerous small dark-coloured petechiæ, lying under the epicardium. *On section, Left Ventricle* presents one extravasation, dark in colour, lying beneath one of the curtains of the auriculo-ventricular valve. *Abdominal cavity* free from fluid. *Liver* weighs 13 lbs. 3½ ozs. There are numerous calcareous nodules dotted about on the anterior and posterior surfaces of the organ, numerous lymphatic vessels are mapped out on the convex surface, and there are signs of old perihepatitis present. *On section* tissues of a deep red colour, few calcareous nodules dotted over the cut surfaces. *Stomach.—Cuticular* portion pale ; *villous* portion, mucous membrane considerably congested, and at the junction of the two there is a thin line of ulceration. *Spleen* weighs 1 lb. 6¾ ozs., convex surface dotted over with spots of a brick-red colour, while on the concave surface there are enlarged lymphatic vessels, which contain a clear transparent fluid. *On section* tissues dark in colour but firm *Kidneys.*—Right weighs 1 lb. 11 ozs. ; the Left 1 lb. 8¾. External surfaces of organs petechiated. *On section* tissues dark in colour and vessels injected. *Small Intestines.*—Superficial ulceration on the surface of mucous membrane, extending down the gut for 6 inches from the pyloric orifice. Small patches of congestion are dotted over the mucous membranes throughout its whole length. *Colon.*—Mucous membranes yellow in colour, also patches of congestion on its surface. *Bladder* is distended with orange-coloured urine, and there are some ecchymoses round the neck of the organ.

No. CXII.—Grey Persian Gelding, aged 13 years (No. 61), was purchased by the Bombay Tramway Company on the 26th November 1887. Animal first noticed to be ailing 31st October 1894. Hæmatozoon discovered in the blood 7th November. The animal was received at the Laboratory stables on 9th November. *State on admission.*—Animal very much fatigued, in fair condition. Visible mucous membranes tinged an orange colour, conjunctivæ petechiated. Skin hot, pulse accellerated and feeble. Swelling and œdema of scrotum and under-surface of the abdomen. There is some swelling and œdema of the fetlocks, but they are cool and not tender. Hæmatozoa very numerous in the blood. On the evening of its arrival the animal was put on Arsenic (grs. iv), in the form of Liquor Arsenicalis, in gradually increasing doses. After 24 grains had been administered, the hæmatozoon disappeared from the blood (November 12th), and between that date and death, which took place on January 23rd, 1895, a period of 73 days, did not re-appear. Arsenic to the amount of 539·5 grains was administered in all, but no medicine was given for 13 days previous to death. On the 39th day of the intermission the temperature commenced to rise and on the 40th day registered 40·5°C., when lymphangitis of the near hind limb developed, and continued for some days. Some leeches were applied with success. Between the date of admission and death the temperature oscillated between 40·5° and 37·0°C.

Autopsy.—Body emaciated, œdema and swelling of the extremities. *Thorax.*—No fluid in pleural cavities and adhesions of pleuræ.

Lungs.—Anterior lobes seat of localized emphysema, otherwise healthy. *Pericardium* contains one ounce of an orange-coloured fluid. *Heart* weighs 5 lbs. 3 ozs. Organ presents a healthy appearance. *Abdominal cavity* free from fluid. *Liver* weighs 7 lbs. 4½ ozs., signs of old perihepatitis, and a few calcareous nodules are dotted over both surfaces. *On section,* tissues appear healthy. *Spleen* weighs 1 lb. 14 ozs., healthy. *Kidneys.*—Right weighs 1 lb. 5 oz., left 1 lb. 4 ozs., tissues healthy. *Large* and *Small Intestines* healthy. *Bladder* ditto.

No. CXIII.—Persian-Gulf Entire horse, aged 5 years, belonging to the Bombay Mounted Police (No. 41), was purchased on June 2nd, 1894, and was kept in Bombay until 2nd November, when it was sent to the Veterinary College Hospital, Parel, and remained there until the 27th. Organism first observed on the 8th November. The animal was received at the Laboratory stables on the 28th. *On admission.*—Animal in fair condition, ordinary symptoms of fever present, visible mucous membranes injected, no conjunctival petechiæ. Slight œdema of the fetlocks. Temperature 39·5°C. Pulse 48. Respiration 24. Hæmatozoon absent from the blood. On the evening of its arrival the horse was put on Arsenic (grs. iv) in the form of Liquor Arsenicalis, in gradually increasing doses. After 33 grains had been administered the hæmatozoon disappeared from the blood (December 3rd), and between that date and death on the 13th December, a period of 11 days, did not re-appear. On the third day of the intermission the temperature registered 41·2°C., and then gradually fell, but just before death rose from 37·1 to 38·9°C. One hundred and thirty-five and a half grains of Arsenic were given in all.

Autopsy.—Body emaciated, no swelling or œdema of the extremities, &c. *Thorax.*—Pleural cavities normal. *Lungs.*—Anterior lobes seat of emphysema, otherwise healthy. *Pericardium.*—Small quantity of a yellow-coloured fluid. *Heart* weighs 5 lbs. 3½ ozs. *On section,* lining membrane of cavities stained yellow in colour, no petechiæ. *Abdominal cavity* free from fluid. *Liver* weighs 16 lbs. 15½ ozs., and is considerably enlarged. Old perihepatitis, no nodules. *Spleen* weighs 2 lb. 4½ ozs. Surface covered with varicosed lymphatic vessels, yellow caseous masses in the course of the lumen of the vessels. *On section,* tissues firm, on pressure caseous pus exudes from the blocked tubes. There are several caseous glands in the hilum of the organ. *Kidneys.*—Right weighs 1 lb. 12½ ozs., left 1 lb. 10½ ozs., tissues healthy. *Stomach* distended with food. *On section,* foul-smelling gas escapes. *Cuticular* portion stained yellow. The mucous membranes of *villous* portion slightly congested. Three tumours produced by *Spiroptera megastoma*. *Small Intestines* present a healthy appearance. *Bladder* ditto.

No. CXIV.—Australian Entire horse, aged 5 years, belonging to the Bombay Mounted Police (No. 58), was purchased on 6th June 1894, and kept in and around the city until November 21st, when it was observed to be ailing. On the following day it was removed to the Veterinary College Hospital for treatment, and the organism was discovered in the blood. The horse was received at the Laboratory stables on November 28th. *On admission.*—In very poor condition, ribs visible, belly tucked up, and there is considerable loss of flesh. Visible mucous membranes excessively pale and anæmic, no petechiæ. Ordinary signs of fever, together with some swelling and œdema of fetlocks. Dung soft and pultatious. Temperature 40°C. Pulse 64. Respiration 12. Hæmatozoa few in the blood. On the evening of its arrival the animal was put on Arsenic (grs. iv) in the form of Liquor Arsenicalis in gradually increasing doses. After 23 grains had been administered the hæmatozoon disappeared from the blood (December 2nd), and between that date and death on the 12th December, did not re-appear. On the morning of the 30th of November the temperature registered 37°C., but from that date until the evening of the 10th December it gradually rose and registered 41·7°C. (107·06°F.), but during this interval there were always remissions in the morning. In all 92·5 grains of Arsenic were administered.

Autopsy.—Body considerably emaciated, some œdema of the lower extremities. *Thorax.*—No fluid nor adhesions of the pleuræ. *Lungs—Right* antelobe consolidated. *On section* individual lobules deep red in colour, separated by a thin layer of greenish coloured jelly. Remaining portion of lung and left antelobe healthy. *Pericardium* contains several drachms of semi-turbid fluid. *Heart* weighs 5 lbs. 11 ozs., healthy. *Abdominal cavity* contains 19·5 ounces of a turbid orange-coloured fluid. *Liver* weighs 15 lbs. 6 ozs., enlarged, old perihepatitis. *On section* tissues deep red colour, firm, few calcareous nodules. *Spleen* weighs 1 lb. 5½ ozs., petechiated. Tissues healthy on section.

Kidneys.—Right weighs 2 lbs. 8 ozs., left 2 lbs. 11¾ ozs. Capsules strip easily, stellate veins injected, organs much enlarged. *Stomach.—Villous* portion somewhat dark in colour and emits a foul odour, due to *Spiroptera* nests. *Small Intestines*, portion bordering on the Ilio-cœcal valve, mucous membranes congested, no ulceration or erosion of surface. *Large Intestines* mucous membrane highly congested, and there are signs of blood on the contained dung. *Rectum* mucous membranes congested, surface covered with a glairy viscid material. *Bladder* contains 25 ounces of orange-coloured urine. *On section* mucous membranes healthy.

No. CXV.—Persian-Gulf Entire Horse, aged 4 years, was purchased on the 16th July, and kept in Bombay until the 23rd November 1894, when Surra was diagnosed. There is, therefore, no doubt that the disease was contracted in Bombay. On November 23rd the temperature was 40·4°C. (104·8°F.). Pulse 60. Respirations 52. The animal was received at the Laboratory stables on November 29th, on the evening of its arrival was placed on treatment consisting of Arsenic (grs. iv.) twice daily in gradually increasing doses.

The hæmatozoon was present in the blood whilst under observation from the 22nd to 25th day of the disease inclusive, but after 38 grains of Arsenic had been administered it disappeared and did not recur. During the early days of treatment, December 5th and 6th, an urticarial eruption involving the under-surface of the abdomen and thighs appeared and persisted for 24 hours. In all 455 grains of Arsenic were administered in sixty-three days, after which Sodium Iodide in two-drachm doses was continued twice daily for seventy-two hours.

The animal made an uninterrupted recovery, and was returned to the Bombay Mounted Police, for duty on March 9th, cured. From letters received in 1895, 1896, 1897 we hear that the animal is in good health and condition.

It is here worthy of notice that this horse is the first animal on record which has been cured of naturally contracted or spontaneous Surra.

No. CXVI.—Australian Gelding, aged 11 years, belonging to the Bombay Tramway Company (No. 388), was purchased on the 28th January 1889. Animal was observed to be ailing on the 17th October 1894, but the hæmatozoon was not discovered until 29th November. The animal was received at the Laboratory stables at 9 A.M. on 1st December. *On admission*, horse is in poor condition, ribs visible. The visible mucous membranes present a yellow tinge. Conjunctival membranes petechiated. Some swelling and œdema of the scrotum and sheath running forward along under-surface of abdomen; the fetlocks are also œdematous. Small melanotic tumour on prepuce. Appetite poor, owing to sharpness of teeth, numerous small ulcers on the buccal mucous membranes. Dung contains undigested corn, odour offensive. On the day of arrival the animal was placed on a treatment of Arsenic, but from the first the case was recognised as a hopeless one. The hæmatozoon disappeared from the blood after ten grains of the chemical had been administered, and did not again re-appear in the circulation. One hundred and fifteen grains in all were given previous to death, which took place on December 14th. The temperature oscillated between 40°C. (104°F.) and 37·4°C. (99·3 °F.), and ran up from the latter figure to 39·1°C. just before the animal succumbed.

Autopsy—Body somewhat emaciated, slight œdema of extremities. *Thorax*—No fluid, and no adhesions of the pleuræ. *Lungs* present a healthy appearance. *Pericardium.*—The sac contains one drachm of an orange-coloured fluid. *Heart* weighs 7 lbs. 3½ ozs., considerably hypertrophied. *Internal surfaces* free from extravasation. *Abdominal cavity* contains several pints of a straw-coloured fluid. *Liver* weighs 17 lbs. 7 ozs., considerably enlarged. Old perihepatitis, and a few calcareous nodules. *On section* tissues nut-meggy, calcareous bodies invading deep structures. *Spleen* weighs 1 lb. 7⅓ ozs., few sub-capsular petechiæ on convex surface. *On section* tissues firm. *Kidneys.*—Right weighs 1 lb. 15 ozs., left 2 lbs. 0¾ oz. Capsules strip easily, stellate veins injected. *On section*, tissues deeply congested, blood flows from cut end of the vessels. *Small and Large Intestines* present a healthy appearance. *Bladder* ditto.

CXVII.—Australian Gelding (coarse bred), aged nine years, belonging to the Bombay Tramway Company (No. 502), was purchased 28th January 1890. Admitted to Infirmary 29th November 1894, and the Surra hæmatozoon was discovered in the blood at the same time. The animal arrived at the Laboratory Hospital at 9 A.M., December 1st. *State on admission.*—The animal is in fair condition, abdomen somewhat 'tucked up.' Ordinary symptoms of fever present. Visible mucous membranes bright orange colour, right conjunctival membrane petechiated, excessive lachrymation present. Temperature 40·3°C. Pulse frequent but regular, and of low tension, 46. Respiration 24. Absence of swelling and œdema. Appetite fairly good. Hæmatozoa numerous in the blood. On the evening of December 1st the animal was submitted to treatment by Arsenic (grs. v) during a paroxysm. The hæmatozoon disappeared from the blood on the following morning, but again re-appeared after 48 hours and remained present for two days, finally making its departure after 37 grains of the chemical had been administered. During the whole case 114·5 grains were given. The temperature varied between admission and death, which occurred on the 17th December, between a maximum of 40·3°C. and a minimum of 36·6°C.

Autopsy.—Body fairly nourished. Some swelling and œdema of the fetlocks. *On section* tissues and membranes stained a deep orange colour. *Thorax.*—No fluid, no adhesions. *Lungs.*—Sub-pleural extravasations invading both organs. *On section* tissues healthy. *Pericardium* free from fluid. *Heart* 6 lbs. 4 ozs. Right cavity blood-stained, all free from extravasations. *Abdominal cavity* free from fluid. *Liver* 11 lbs. 3 ozs. Old perihepatitis. *On section* tissues fairly healthy. *Spleen* 1 lb. 8¼ ozs. few sub-capsular petechiæ. *On section*, tissues firm, present healthy appearance. *Kidneys.*—Right 1 lb.

3½ ozs., Left 1 lb. 2¾ ozs. Capsules strip easily. No petechiæ. *On section* cortical tissues pale, medullary vessels injected. *Stomach.—On section, Villous* portion few small patches of congestion, involving mucous membranes about 1½ inches from pyloric opening. *Small Intestine*—mucous membranes somewhat congested in whole length. No ulceration. *Large Intestine* healthy. *Bladder* ditto.

CXVIII. Australian Gelding, aged 16 years, belonging to the Bombay Tramway Company (No. 128), was purchased 14th January 1884. Admitted into Infirmary with fever, 3rd December 1894. Surra hæmatozoon detected the same day. The horse arrived at the Laboratory stables at 9 A.M., December 5th. *State on admission.*—Animal in poor condition, dull, head hangs down between forelimbs. Ordinary symptoms of fever present. Visible mucous membranes present a faint yellow colour. Right conjunctival membrane is considerably injected and petechiated, left, injection slight, petechiæ more marked. Sheath swollen and œdematous, lower limbs are full, but not tender on pressure. Temperature 40 8°C.; pulse frequent and small, 60; breathing frequent and shallow, 35. Appetite good. Dung natural. The animal was submitted to treatment, Arsenic (grs. 2½) being administered on the evening of its arrival, but on the following day a dose of grs. vi was given. After one dose the hæmatozoon disappeared from the blood, and did not again re-appear in the circulation. On the 25th day of the intermission the temperature rose to 41·2°C., and it was expected that the organism would again be present in the blood, but death supervened December 30th, 1894. Temperature oscillated, during the period the horse was under observation, from a maximum of 41·9°C. (107·4°F.) to a minimum of 37·4° C. (99·3°F.). In all 150·5 grains of Arsenic were given in 26 days.

Autopsy.—Body fairly nourished. Some swelling and œdema of lower extremities. *Thorax*-Pleural cavities contain few ounces of a turbid, sherry-coloured fluid. *Lungs.*—Few small calcareous nodules dotted over surface of the organs, but no petechiæ. *Pericardium* sac contains a few drachms of an orange-coloured fluid. *Heart* 6 lbs. 11 ozs. *Left ventricle* few petechiæ. *Abdominal cavity* free from fluid. *Liver* 13 lbs 14 ozs. Capsule opaque in patches, few calcareous bodies dotted over surface of organ. *On section* contains much blood. Tissues healthy. *Spleen* 1 lb. 13½ ozs., firm on section. *Kidneys.*—Right 1 lb. 7 ozs., Left 1 lb. 5¾ ozs. *On section* the cortical portion of both organs presents a vertical striation, dark red in colour, alternating with a dull white medullary substance, pale. *Stomach.*—Mucous membrane of villous portion presents spiroptera tumour, otherwise healthy in appearance. *Intestines* healthy. *Bladder* ditto.

CXIX.—Herati Gelding, aged 8 years, belonging to the Bombay Tramway Company (No. 822), was purchased on 21st January 1891, was admitted into the Infirmary with fever on 4th December 1894, and the hæmatozoon was discovered in the blood at the same time. The animal arrived at the Laboratory stables at 9 A.M. on the 6th December. *State on admission.*—The horse is in excellent condition, but presents a dull appearance. Visible mucous membranes are a bright yellow coloured, injected, and both conjunctival membranes are petechiated. Skin hot, temperature 40·5°C. There is an urticarial eruption on the hind quarters and extremities and some swelling and œdema of the fetlocks. Pulse frequent and thready, 60. Respiration 20. Hæmatozoa very numerous in the blood. Red corpuscles form healthy rouleaux 7,400,000, white 10,000 in 1 c. mm. or ratio of 1 : 740. Appetite poor. Dung normal in character. The animal was submitted to treatment, Arsenic (grs. v) being administered on the evening of its arrival, followed subsequently by gradually increasing doses, until as much as 24 grains were given during the 24 hours. On the day after admission the temperature registered 41·3°C. (106·3 °F.) but fell next day to 38·1°C. (100·6°F.), and remained during the following seventy (70) days within normal limits. In this interval 514 grains of Arsenic were administered. On the 15th February (P.M.) the temperature rose to 39·3°C. and during the three following days the Surra organism re-appeared in small numbers in the circulation. A second intermission commenced on the 19th February 1895, 79th day of the disease, and continued until 21st April 1895, 140th day of the disease, during which interval 444 grains of Arsenic were given. The organism again appeared in small numbers for a period of four days, and a third intermission occurred which occupied 15 days, followed by a fourth paroxysm lasting one day, 10th May. Up to this time, the 159th day of the disease, 1,232 grains of Arsenic had been administered to the animal. On the 16th May, the establishment of the Laboratory removed to Muktesar, so this animal was left at the Sangam Veterinary Hospital under the care of Mr. Judas Hyam, the Veterinary Graduate in charge. The Arsenical treatment was continued until death supervened on July 2nd, 1895. From May 10th to the date of death, a period of 53 days, 1,007 grains of Arsenic were taken by the animal, and finally symptoms of poisoning were observed. Unfortunately the telegraph lines were not laid to Muktesar at that time and ordinary telegraphic messages between the two stations were frequently not delivered for five days, consequently directions wired as to treatment were useless. Arsenic to the amount of 2,239 grains were taken by the animal in 209 days equivalent to a daily dose of 10·7 grains for that period.

Autopsy.—Not made until 16 hours after death. Animal in fine condition, no swelling or œdema present.

Thorax.—No fluid or adhesions. *Lungs*, anterior lobes, localized emphysema. *Pericardium*, sac contains a drachm of fluid.

Heart.—Normal in size, presents a healthy appearance.

Liver.—Somewhat large; *spleen* much enlarged.

Post-mortem changes too far advanced for any slight changes to be recognized.

CXX.—Persian-Gulf Entire Horse, aged 7 years, belonging to the Bombay Mounted Police, (No. 53), was purchased during the rains of 1894, was first observed to be ailing on 1st December, and

sent to the Veterinary College Hospital, Parel, on 4th December, when the hæmatozoon was discovered in the blood. The animal was received at the Laboratory stables on 10th December. *State on admission.*—Animal presents a very dull appearance, and is in poor condition, ribs showing. Visible mucous memberanes pale, right conjunctival membrane petechiated, left free. No œdema or swelling visible. Skin hot. Temperature 40·5°C., Pulse 60, Respiration 20. Complete loss of appetite. Sphincter ani relaxed and slight prolapse of rectum. Hæmatozoa are present in small numbers in the blood. On the evening of the 10th the animal was subjected to a treatment consisting of Liquor Arsenicalis (grs. v) in gradually increasing doses, later to be altered according to the condition of the patient. After 15 grains had been taken the hæmatozoon disappeared from the blood, and continued free until the end of the case, on January 15th, 1895, when death took place, a period of 34 days. In all 198 grains of Arsenic were administered. The temperature varied during the period the animal was under observation between a maximum of 40·3°C. and a minimum of 35·7°C. but rose again slightly just before death.

Autopsy.—Body fairly nourished, no swelling or œdema of limbs.

Thorax.—No fluid or adhesions. *Lungs* large and occupy the whole cavity of the chest. *On section* organs œdematous. *Pericardium* contains few drachms of fluid. *Heart* 4 lbs. 11 ozs., healthy.

Abdominal Cavity free from fluid. *Liver* 1 lb. 1 oz., old perihepatitis. *On section* tissues dark-red in colour, but healthy in appearance.

Spleen 1 lb. 3½ ozs., somewhat small. *On section* tissues firm, &c.

Kidneys.—Right 1 lb. 14½ ozs., left 1 lb. 13½ ozs. *On section* tissues healthy. *Stomach.—Cuticular* portion stained yellow, *villous* healthy appearance.

Large and *Small Intestines*, ditto. *Bladder* ditto.

CXXI.—Persian-Gulf Entire Horse, aged 5 years, belonging to the Bombay Mounted Police, (No. 96), purchased during July 1894, was observed to be ailing on November 20th. A few days later it was admitted to the Veterinary College Hospital, Parel, where the hæmatozoon was discovered on 3rd December. The animal was received into the Laboratory stables on 10th December. *On admission.*—The horse is in fair condition, the visible mucous membranes are of an exceeding pale yellow colour, but there are no petechiæ present. Skin is hot. Temperature 40·5°C. Pulse accelerated, 90 per minute, bounding in character. Respirations quick and shallow, 41. No œdema or swelling of the extremities, &c. Appetite fair. Dung normal in character. The hæmatozoa are swarming in the blood. Ratio of white to red corpuscles 1 : 179. On the evening of its arrival the animal was submitted to a treatment of Arsenic (grs. v) in gradually increasing doses. After the first dose of the chemical the hæmatozoon disappeared from the blood and did not re-appear. The temperature oscillated between a maximum of 41·6°C. (106·9 °F.) and a minimum of 36·7°C. (98·06 °F.). Death occurred on the 24th December. In all the animal received 118 grains of Arsenic.

Autopsy.—Body somewhat emaciated, no swelling or œdema of the extremities. *Thorax.*—No fluid or pleural adhesions. *Lungs*, healthy appearance. *Pericardium* sac contains about two-thirds of an ounce of clear fluid. *Heart* 5 lbs., healthy. *Abdominal cavity* free from fluid. *Liver* weighs 13 lbs. 4½ ozs., old perihepatitis, few calcareous nodules. *On section* tissues dark, somewhat friable. *Spleen* 1 lb. 9½ ozs., healthy. *Kidneys*.—Right 1 lb. 15 ozs., Left 1 lb. 12 ozs. Stellate veins injected. *On section* tissues dark but appear healthy. *Stomach*, healthy. *Large* and *Small Intestines* ditto. *Bladder* ditto.

CXXII.—Persian-Gulf Entire Horse, aged 6 years, belonging to the Bombay Mounted Police, (No. 96), was purchased during the rains of 1894. The animal was first observed to be ailing on November 20th, and was sent to the Veterinary College Hospital at Parel, where the Surra hæmatozoon was discovered on November 28th, 1894. The horse arrived at the Laboratory stable at 7-30 A.M., on December 10th. *State on admission.* The animal is in fair condition. The visible mucous membranes are very pale, conjunctival membranes clear and not petechiated. The skin is hot. Temperature 39·3°C., pulse 48, respiration 16. There is no swelling or œdema of the extremities or under-surface of the abdomen. Appetite good, excreta normal in appearance. Hæmatozoa few in the blood. On the evening of its arrival the animal was subjected to a treatment consisting of Arsenic (grs. v) in the form of Liquor Arsenicalis, the dose to be gradually increased. The hæmatozoon disappeared from the blood after 38 grains had been administered. From the 10th to the morning of the 21st December, 130 grains were given, but on account of gastric symptoms intervening, the medicine was discontinued from the evening of the 21st to that of 27th December. From this time the dose of Arsenic was lowered to grs. iii, twice daily, but later was increased by one grain at a time, and continued until January 18th, 1895. Amount given during second period was 203 grains, making a total of 338 grains. From the evening of the 19th to the 25th January the animal was again allowed a respite from the drug, but it was recommenced on the evening of the latter date, and continued in small doses until the 31st January, when gastric symptoms again supervened. Sodium Iodide was substituted, and continued in two-drachm doses until twelve drachms had been given. Unfortunately on the 53rd day of the intermission owing to the break in the Arsenical treatment for the reasons above given the hæmatozoon re-appeared in small numbers for one day only (February 4th). Again the Arsenical treatment was pushed from this latter date to March 26th, with two periods of rest, 7½ and 7 days, during which 226 and 162 grains were respectively administered. But after this second intermission lasting 49 days one hæmatozoon was found in two large cover-glass specimens of blood. The further ingestion of Arsenic was abandoned during the next 9 days, and intravenous injections of two grains on the 26th and 4 grs. on the 29th December were substituted; but

again the Surra organism made its appearance in the blood, and remained with one exception, 9th, from the 5th to the 10th of April. At this period of the case (April 8th) the animal assumed the recumbent position, and when placed in slings fell forward, so after several unsuccessful attempts to get it to stand, further trials were abandoned. It was recognised that if the animal was left in this condition, death would ensue after 24 or 36 hours of severe struggling, consequently a novel treatment was resorted to, viz., the subcutaneous injection of glycerine extracts of the spleen and testicles of the sheep, 2. c.c. of each. On the morning of 9th, the animal assumed the erect position without assistance. Further injections were made of spleen 2·5 c.c. alone on the 10th, spleen and testicle combined, 2·5 c.c. of each on the 12th and 14th April. Death took place on the 24th April, the 148th day of the disease, but during the interval of 16 days until the evening of the 23rd April the animal was able to lie down and get up, without any assistance. In all 814 grains of Arsenic were administered during the 136 days the animal was under treatment. The temperature varied between a maximum of 40·2°C. (104·3 °F.) and a minimum of 37·1°C. (98·8°F.).

Autopsy.—Body somewhat emaciated, slight swelling and œdema of the fetlocks. *Thorax*, no fluid, no adhesions of the pleuræ. *Lungs*—anterior lobes seat of emphysema. *On section* œdema of lungs. *Pericardium* sac contains one ounce of amber-coloured fluid. *Heart* weighs 4 lbs. 5½ ozs., base of organ petechiated. *On section* healthy. *Abdominal Cavity* contains few ounces of a clear amber fluid. *Liver* 9 lbs. 6 ozs., old perihepatitis. *On section* tissues pale, *spleen* 2 lbs. 11 ozs. *On section* tissues firm. *Kidneys.*—Right 1 lb., 3 ozs., Left 1 lb. 5½ ozs. The capsules strip easily; *on section* tissues dark in colour. *Stomach.*—*On section* half full semi-digested food, *villous* portion, mucous membrane presents a pale rose colour, tenacious mucus covering the surface of the organ. Small *spiroptera* tumour midway between openings. *Small Intestines*—mucous membranes congested patches present. *Large Intestines* healthy. Bladder ditto.

CXXIII.—Persian-Gulf Entire horse, aged 6 years, belonging to the Bombay Mounted Police, was purchased on the 13th December 1891. From the above date until December 14th, 1894, when the animal was observed to be ailing, it was stationed in and around Bombay. From the 1st to 21st October 1894, thirty-five pounds of green grass was given daily as fodder, but previous to and since the above period, grain or some kind of corn and dry grass constituted the daily ration. From 14th to 22nd December under treatment at the Veterinary College Hospital, Parel. The horse was received at the Laboratory stables at 7-30 A.M., 23rd December. *State on admission.*—Animal in poor condition, presents a dull appearance. Visible mucous membranes injected and conjunctivæ tinged an orange colour and petechiated. Skin hot, ordinary symptoms of fever present. Temperature 40·8°C. Pulse rapid, full and bounding, 72. Respirations frequent and shallow, 32. Swelling and œdema of the sheath, scrotum and extremity. Off feed. Dung glairy and offensive. Hæmatozoa very numerous in the blood. On the evening of its arrival the animal was subjected to Arsenic (grs. v) in the form of Liquor Arsenicalis, the dose to be gradually increased. The hæmatozoon disappeared from the circulation after 15 grains had been administered and continued absent until the 13th February, an intermission of 50 days' duration. During this period the drug was stopped on two occasions for 7½ and 3 days respectively, on account of slight gastric symptoms appearing. Up to this date 335 grains had been readily taken in the fluid imbibed. On this occasion only one hæmatozoon was observed in two cover-glass specimens of blood. The Arsenical treatment was continued until March 3rd, when the animal refused fluid in any form if the drug was mixed with it, and a few days later the temperature began to rise and death took place at 2 A.M. on the 16th March 1895. During the 81 days the case lasted 580 grains of Arsenic were administered, the temperature varied between a maximum of 40·8°C. and a minimum of 36°C.

Autopsy.—Body fairly nourished. No œdema present, *Thorax.*—No fluid or adhesions. *Lungs* anterior lobes seat of emphysema, *on section* tissues present healthy appearance. *Pericardial* sac contains a few drachms of a clear fluid. *Heart* 5 lbs. 4 ozs. *On section* right side of heart, membranes blood-stained, *Left* membranes present mottled appearance, probably fatty change. *Abdominal cavity* free from fluid. *Liver* 10 lbs. 5 ozs., old perihepatitis, *on section* tissues dark and somewhat friable, *Spleen* 2 lbs. 12 ozs., somewhat enlarged, *on section* tissues firm. *Kidneys.*—Right 1 lb. 7 ozs., Left 1 lb. 6 ozs., capsules strip easily, *on section* organs pale. *Stomach* distended with food, *on section* mucous membrane of *villous* portion presents a rose colour, more particularly bordering on the line of demarcation. *Small Intestines* present a healthy appearance; *Large* ditto. *Bladder* vessels highly injected, and mucous membranes varying in colour from yellowish red to a deep red.

CXXIV.—Persian Gulf Entire horse, aged 7 years, belonging to the Bombay Mounted Police, was purchased 16th July 1894. During the time which elapsed between the above date and recognition of the disease the animal was located in and around the City of Bombay. It was taken for treatment to the Veterinary College Hospital, Parel, on 6th December, and later on the 23rd of the same month was received at the Laboratory stables. *State on admission.*—Animal in poor condition, presents a dull appearance, symptoms of fever are present. The visible mucous membranes are injected; the conjunctivæ are petechiated, lachrymation excessive. Skin hot, temperature 40·3°C., Pulse frequent, 68; Respirations rapid and shallow, 56; some swelling and œdema of the extremities. Appetite poor. Dung natural in character. Hæmatozoa few in the blood.

The animal was placed on a treatment of Arsenic in form of Liquor Arsenicalis, in increasing doses commencing with grs. v twice daily. The hæmatozoon disappeared from the circulation after 26 grains had been given, and up to the time of death on February 8th, a period of 45 days, had not re-appeared. In all 389·5 grains of Arsenic were administered. A marked feature in this case was that from the first dose of Arsenic on the evening of the 23rd December until the 10th January 1895 the temperature gradually

declined from 40·5°C. to 37·4°C., the evening reading then gradually rose until 38·9°C. was registered on the 19th January, again the temperature gradually rose from 37·8°C. on the evening of 2nd February to 39·2°C. on the day previous to death.

Autopsy.—Body somewhat emaciated, absence of swelling and œdema. *Thorax* nil. *Lungs* present a healthy appearance. *Pericardium* contains about a drachm of clear fluid. *Heart* 5 lbs. 12¼ ozs. *On section* present healthy appearance. *Abdominal cavity* free from fluid. *Liver* 10 lbs. 10½ ozs. Old perihepatitis, *on section* tissues healthy. *Spleen* 2 lbs. 1½ ozs., *on section* tissues appear healthy. *Kidneys.*—Right 1 lb. 3 ozs., Left 1 lb. 1½ ozs. Capsules strip easily. *On section* tissues appear healthy. *Stomach, villous* portion, mucous membrane seat of catarrhal inflammation. *Intestines* healthy. *Bladder* ditto.

CXXV.—Persian-Gulf gelding, aged 11 years, belonging to the Bombay Tramway Company, was noticed to be ailing with fever on the 27th January and was removed to the Infirmary. On the following day the hæmatozoon was discovered on microscopical examination of the blood. The animal was received at the Laboratory stables on 30th January.

State on admission.—Animal in fair condition, fetlocks overshot. Fever present, visible mucous membranes are injected and orange in colour. Conjunctivæ petechiated, excessive lachrymation. Skin hot. Temperature 40·2°C. Pulse full, somewhat hard, 60. Respiration 16. Extremities seat of some swelling and œdema, but not tender on manipulation. Appetite good. Dung healthy in appearance. Hæmatozoa numerous in the blood. Red blood corpuscles form rouleaux and the white corpuscles are not increased in number. The animal was placed on Arsenic, grs. v twice daily. Dose to be increased later. The hæmatozoon disappeared from the blood after one dose had been administered, and remained absent up to time of death which occurred on the night of February 4th. Forty-four grains of Arsenic were given during the five and half days the animal was under treatment. The temperature varied between a maximum of 40·5°C. and a minimum of 37·2°C.

Autopsy.—Body well nourished, thick layer of adipose tissue beneath abdominal walls. All the tissues of body stained yellow in colour. *Thorax* contains no fluid, no adhesions. *Lungs* present a healthy appearance. *Pericardium* contains about a drachm of orange-coloured fluid. *Heart* 6 lbs. 7¼ ozs. Organ enlarged. Dilatation of right side of heart. Hypertrophy of walls of left ventricle. No sub-endocardial petechiæ. *Abdominal Cavity* free from fluid. *Liver* 13 lbs. 10 ozs. Old perihepatitis. Lymphatic vessels on both anterior and posterior surfaces stand out, injected with a clear, colourless fluid. *On section* tissues pale and friable. *Spleen* 2 lbs. 1 oz. *On section* tissues normal in appearance. *Kidneys.*—Right 1 lb. 5¼ ozs. Left 1 lb. 4¾ ozs. Capsules strip easily. *On section* tissues very pale. *Stomach* presents a healthy appearance. *Intestines* ditto. *Bladder* ditto.

(ii).—Inoculated cases by Gastric Ingestion of blood.

No. XCVI.—Country-Bred Entire, aged, purchased for experimental purposes on 17th October 1893. *On admission.*—The animal is in fair condition, but apparently free from disease. The visible mucous membranes are clear, with the exception of the conjunctivæ which are injected. Temperature 38°C. Pulse 36. Respiration 12. The appetite is good and the dung healthy in appearance. On the 18th October the animal was inoculated by the gastric ingestion of four ounces of Surra blood taken from the jugular vein of horse No. XCV immediately after death. Ante-mortem the blood contained very numerous hæmatozoa. The latent period occupied between 7 and 8 days. On the evening of the day the hæmatozoon was discovered in the blood the animal was submitted to a treatment with Arsenic (grs. iv) in the form of Liquor Arsenicalis, one grain being added each day to the original quantity (grs. viii) until 12 grains were reached. The only paroxysm lasted for five days and the hæmatozoon disappeared from the circulation after 46 grains of Arsenic had been administered. The intermission which followed extended over a period of eleven days, and early on the morning of the 12th day the animal succumbed. The temperature varied between a maximum of 40·6°C. during the paroxysm, and a minimum of 35·2°C. during the intermission. In all 178 grains of Arsenic were given during the 15½ days the animal was under treatment, or daily mean of 11·6 grains.

Autopsy.—Body emaciated, no œdema of the extremities. *Thoracic* cavity free from fluid and adhesions. *Lungs* emphysematous throughout. Sub-pleural extravasations on both organs. *Pericardium.*—The sac contains 6 ounces of a blood-stained fluid. *Heart* 5 lbs. 7 ozs., presents a healthy appearance. *Abdominal cavity* free from fluid. *Liver* 6 lbs. 15 ozs., old perihepatitis, small yellowish white calcareous nodules scattered over the surfaces of the organ. *On section* tissues dark in colour, nodules scattered through the structures of the organ. *Spleen* 1 lb. 1 oz., both surfaces dotted over with bright red coloured petechiæ. *On section* tissues dark and flabby. *Kidneys.*—Right 13½ ozs., Left 16½ ozs., organs healthy. *Stomach* contracted. *On section*, walls thickened. *Cuticular portion* presents several tumours, one large and several small. *On section*, the large tumour contains a yellow gelatinoid material. *Villous portion.*—The mucous membrane presents one large extravasation of blood lying beneath the mucosa, and a *Spiroptera* tumour from which a small quantity of a saneous fluid exudes. *Duodenum* mucous membranes injected. *Small Intestines* contain a yellow coloured fluid, the mucous membrane is covered with a yellow gelatinous material which is also present on the mucous membrane of the rectum. *Bladder* contains 740 c.c. of turbid, viscid greenish yellow coloured fluid. Specific Gravity 1040, containing 5 grammes of urea per 100 c.c.

Two Guinea Pigs were inoculated on the 3rd November 1893, with 0·3 c.c. of blood each (from which the organisms appeared to be absent on microscopical examination) taken from the jugular vein of Horse No. XCVI, on the 9th day of the disease after 88 grains of Arsenic had been administered.

No. I.—Result negative :—Blood examined for 103 days.

No. II.—Result negative :— ditto.

Two Guinea Pigs were inoculated on the 10th November 1893, with 0·3 c.c. of blood each, taken from the jugular vein of Horse No. XCVI on the day previous to death after 172 grains of Arsenic had been administered.

No. I.—Result negative :—Blood examined for 34 days.

No. II.— Ditto. ditto 55 days.

No. LXXXIX.—Waler Gelding, aged. This animal with Horse No. XCI was sent to the Veterinary College Hospital, Parel, for the purpose of testing whether Surra could be communicated by gastric ingestion of rat's excrement with corn. The experiment was commenced on May 6th, 1893, and continued until September 26th, 1893, when the animal was returned to Poona, not having contracted the disease. As Horse XCI, which had been subjected to the same treatment, developed Surra the day after its arrival in Poona, the blood of LXXXIX was microscopically examined, and the temperature, &c., recorded daily in order to see whether it would eventually develop any symptoms. As, however, the animal remained in good health up to 24th November, four ounces of soiled blood, containing swarms of hæmatozoa, taken from the heart of horse No. XCVII immediately after death, were administered by gastric ingestion on that date. The latent period occupied six and a half days. Treatment was commenced the same evening, consisting of Arsenic as Liquor Arsenicalis, in grs. iv doses, increasing rapidly to 12 grains daily. After a paroxysm of 5 days, during which time the hæmatozoa were very numerous, they disappeared from the blood. The Arsenical treatment was continued for 65 days, 454 grs. of Arsenic being administered. At this period the animal showed an aversion to the Arsenic in this form. For this reason, and as previous experience pointed to the fact that Arsenic by itself did not in *some* cases destroy the resting or immature form of the hæmatozoon, the Double Iodide of Arsenic and Mercury was substituted, as it was known that the Iodide of Mercury does not form an albuminate, and consequently the whole of the salt would be available. The Iodides were continued for a period of 106 days, in order to ensure the absolute destruction of the immature form. In all 1,822·75 c.c. or 288 grains each of the Tri-iodide of Arsenic and Bin-iodide of Mercury were given. Thirty-three weeks after the medicine had been discontinued, the animal was in good health and condition; and no hæmatozoon had appeared in the circulation for 423 days or over 15 months. For six and a half months during this period the animal averaged 4·5 miles' walking exercise daily. As it did not thrive on gram, barley (boiled) was given in its place, with the most satisfactory results, the animal rapidly putting on flesh. At a later date this horse was utilized to discover whether one attack of Surra protects against a second attack of the same disease.

(iii).—Preliminary treatment, subsequent Inoculation, Arsenic.

No. XCVIII.—Australian mare, aged. After a period of observation lasting 22 days, during which daily observations were recorded of the water drunk, urine passed, and total urea excreted, the animal was submitted to a course of Arsenic in the form of Liquor Arsenicalis with a view to determine the efficacy of subjecting an animal to the drug, sufficient to cause the full physiological effects, previous to submitting it to experimental inoculation with Surra.

The first dose was given on the evening of March 28th, 1894, and the administration of the chemical was continued until the morning of the 21st May 1894. Three hundred and twenty point seven grains in all were administered during a period of 54 days, or a daily mean of nearly 6 grains. At 5 P.M. on the latter date the animal was inoculated over the left scapular region with 0·7 c.c. blood containing a large number of hæmatozoa taken from a Guinea Pig immediately after death. The latent period occupied five days. As no protection was conferred by the Arsenic, which in this case averaged only 6 grains daily instead of at least ten, owing to symptoms of gastric irritation supervening, a treatment of Iodide of Arsenic and Mercury was adopted, but this had to be abandoned for a like cause to the above. The animal succumbed on the 51st day of the disease, during which six paroxysms lasting 27 days and five intermissions lasting 24 days occurred.

Autopsy.—Body fairly nourished. No œdema of the extremities.

Thorax.—Free from fluid and pleural adhesions. *Lungs* healthy.

Pericardium.—Few drachms of a straw-coloured fluid in the sac.

Heart, 5 lbs. 10½ ozs., presents a healthy appearance externally and on section.

Abdominal cavity free from fluid. *Liver* weighs 13 lbs. 3½ ozs. Tissues dark on section. *Spleen* 3 lbs. 6¼ ozs., nearly double normal weight, few sub-capsular petechiæ. *On section* tissues firm and apparently healthy. *Kidneys.*—Right 1 lb. 14⅓ ozs., left 1 lb. 10½ ozs., capsules strip easily, *on section* vessels injected, and Malphigian tufts prominent.

Stomach.—The *cuticular* portion presents several patches rose pink in colour; *villous portion*, the mucous membrane along the line of demarcation and spreading towards the pyloric extremity, is bright crimson in colour.

Intestines healthy. *Bladder* ditto.

In this case the latent period of the disease was not lengthened, but the organisms only attained to very numerous between 20 and 50 in a field of the microscope on four occasions during a period of 51 days the case lasted. Great difficulty was experienced in getting the animal to take the drug, so that although gastric symptoms appeared, the full physiological effect of the Arsenic was never produced.

Preliminary Treatment by Arsenic.

CII.—Country-Bred gelding, aged.

Arsenic administered from 27th June 1894.

In all 430 grains were given.

Death 9 P.M. 29th July 1894.

The animal received an average of 13 grains for 33 days.

Death took place from Arsenical poisoning somewhat suddenly just before the date for the inoculation test.

Iodide of Arsenic and Mercury.

No. XCIX.—Australian Gelding, aged. After a period of observation lasting eight days, during which daily observations were recorded of the water drunk, urine passed, and total urea excreted. The animal was submitted to a course of medicine consisting of the Double Iodides of Arsenic and Mercury, with the same object in view as in the case of No. XCVIII animal. The first dose of v. c.c. was administered on the evening of the 5th April 1894, and continued in increasing quantities until the morning of May 21st, a period of 46 days. In all 158 grains of each salt, Iodide of Arsenic and Iodide of Mercury were given. At 5 P.M. on 21st May the animal was subcutaneously inoculated with 0·8 c.c. of blood containing swarms of hæmatozoa taken from the heart of a Guinea Pig immediately after death. The period of incubation lasted five days, and the case lasted 59 days from the first appearance of the organism in the blood. There were 7 paroxysms lasting 24 days, and 7 intermissions lasting 35 days. As no protection against the Surra hæmatozoon had been conferred by the preliminary treatment of the Double Iodides, the animal was again submitted to the same salts, but in addition a small dose of Arsenic as Liquor Arsenicalis was administered at intervals. During the first five paroxysms the fever assumed the typical relapsing form, for within a few hours the temperature fell from over 41°C. to 37·4°C. equal to 7°F. and on a second occasion from 41·8°C. to 36·8°C. equal to 9·2°F., but during the latter part of the case the temperature oscillated in the most irregular manner. Until six days before death the organism never exceeded few (5 in a field), but frequently there was only one in a cover glass specimen of blood.

Autopsy.—Body fairly nourished, no œdema of extremities.

Thorax free from fluid and pleural adhesions. *Lungs* healthy. *Pericardium,* few drachms of fluid in the sac. *Heart* 6 lbs. 12¼ ozs. *Right ventricle* two small sub-endocardial extravasations. *Left ventricle* several ditto. *Abdominal* cavity free from fluid. *Liver* 17 lbs. 1 oz.; much enlarged. *Spleen* 5 lbs. 12¼ ozs., three times normal size. Numerous sub-capsular petechiæ.

Kidneys.—Right 1 lb. 13½ ozs., Left 2 lbs. 1½ ozs., double healthy weight. Capsules strip easily. Surfaces of both organs petechiated, &c.

Stomach.—Mucous membrane of villous portion presents rose-coloured patches, no ulceration or erosion.

Intestines healthy. *Bladder* ditto.

The latent period of the disease was in no way altered by the administration of 150 grains of each of the Iodides of Mercury and Arsenic, but the course of the paroxysms was undoubtedly modified to a marked degree, only a few hæmatozoa being present at any one time in the blood examined, until a few days before death, and although the disease ran on for over eight weeks, the animal still maintained a fair condition. In this case the temperature assumed the typical relapsing type which is rarely observed in inoculated cases.

Guinea Pig inoculated with 0·4 c.c. of blood from which the organisms were absent, taken from the heart of Horse No. XCIX, 7 hours after death. The latent period occupied 16 days, from the first appearance of the organism on the 9th August, to death on 15th September, 38 days elapsed, made up of 3 paroxysms lasting 29 days and 2 intermissions lasting 8 days.

Preliminary treatment. Iodides of Arsenic and Mercury. Subsequent inoculation.

No. CIII.—Country-Bred, aged. This animal was subjected to a course of the Double Iodides of Arsenic and Mercury in gradually increasing doses, commencing with five cubic centimetres, and terminating with twenty-seven cubic centimetres twice daily with a view to determining whether its administration would modify or destroy the Surra organism on subsequent inoculation. Between June 29th and July 28th, 1894, one thousand and seventy-four c.c. were administered. On 24th July, this animal's temperature, 36·7°C., commenced to rise and at 5 P.M. on the 26th had attained 40°C., and for the next two days remained high. On the morning of the 29th, the Surra hæmatozoon was found in

its blood, and remained present until death on the morning of the 1st August. It was the intention to have continued the drugs for some time longer previous to the subsequent injection of soiled blood being made, but as accidental inoculation took place by a fly or flies it is supposed from a Surra horse standing some yards away, the experiment came to an end prematurely, showing that a mean of 35·8 c.c. of the Double Iodides, persisted in for thirty days, has no destructive effect upon the *Trypanosoma*.

Autopsy.—Body fairly nourished, some œdema of the extremity. *Thorax*.—No fluid in the cavities, no pleural adhesions. *Lungs* localized, emphysema of anterior lobes, several somewhat extensive sub-pleural extravasations on the surfaces of the organs. *Pericardium*.—No fluid in the sac. *Heart* 5 lbs. 4 ozs. gelatinous exudations round the base, dotted over with light red petechiæ. *On section* sub-endocardial extravasations involving both ventricles. *Abdominal cavity* free from fluid. *Liver* 10 lbs. 9¾ ozs. Old perihepatitis, few calcareous nodules dotted through the tissues. *Spleen* 3·8 lbs. 8¾ ozs., double normal weight. Sub-capsular petechiæ over both surfaces of organ. *Kidneys*.—Right 1 lb. 4½ ozs., Left 1 lb. 2½ ozs. Capsules strip easily. The right contains a calcareous nodule imbedded in the cortical portion. *Stomach*.—*Cuticular* portion healthy in appearance. *Villous* portion, mucous membrane petechiated, no ulceration or erosion. *Intestines* present a healthy appearance. *Bladder* presents a healthy appearance.

SECTION V.

Diagnosis.

In order to diagnose Horse Surra, it was stated* that "the demonstration of the *Trypanosoma* will distinguish the disease from all other febrile maladies, and in order to exclude the possibility of any cases presenting dubious symptoms, being those of Surra, it will be necessary to carefully examine microscopically several cover-glass specimens of the blood of the suspected animal for a period of ten days."

During the four years which have elapsed since the above was written, experience has taught one that this is the all-important principle to rely upon, when a diagnosis is required.

The following instance will serve as an example of the difficulty of making a diagnosis in some cases. On December 4th, 1893, a horse in fairly good condition was received at the Laboratory Hospital in Poona, which was thought might be the subject of Surra. Several cover-glass preparations of the blood of this animal were daily examined microscopically from the 4th to the 12th of the month, both days inclusive, a period of 9 days, but no hæmatozoa were discovered. On the evening of the latter date, the animal succumbed somewhat suddenly, and in order to make the diagnosis of the disease sure, two healthy guinea-pigs were each inoculated with 0·3 c. c. of blood taken from the heart of the horse, one hour after death. The blood of inoculated small animals was subjected to daily examination, and on the 9th and 10th days after inoculation the Surra hæmatozoon was discovered in each case respectively, clearly proving that the horse had been the subject of Surra.

On the other hand, one might quote instances in which gentlemen have been so sure that their horses have been the victims of this disease that they have disagreed with the diagnosis of the Veterinary Officer in charge, and requested him to destroy their animals. On that officer refusing to do so, on the plea that the disease was not caused by the *Trypanosoma Evansi*, the owners have then informed him that if he could cure the horses he might keep them as his own property. This he agreed to, and cured them. Now, this form of disease is characterised in equines by symptoms very much resembling those found in an advanced stage of Surra:—yellowness of the visible mucous membranes, conjunctival petechiæ accompanied with rapid loss in condition and the occurrence of relapses.

Animals suffering from these manifestations—a form of so-called *bilious fever*, caused by the presence in the system of an entirely different species of organism to the flagellated protozoon, when carefully treated, frequently or more correctly speaking, in the majority of cases, recover; whereas Surra is an absolutely fatal disease. So here again a certain diagnosis cannot be made without the use of the microscope.

Several other diseases from which horses suffer in this country are accompanied by petechiæ involving the conjunctivæ, during the course of the malady. As a rule, however, these extravasations of blood are small, and of a bright-red colour, differing considerably from the extensive ecchymoses, for the most part involving the *membrana nictitans*, observed in Surra patients. These latter present a varying display of colours, especially when the visible mucous membranes are at the same time bile-stained.

There is one symptom in Surra animals which has been insisted upon by all observers and writers on this disease, namely, a *ravenous appetite*. A desire for food usually ceases with the supervention of fever in the horse, but this disease is an extraordinary exception to the rule. My remark in 1893 was to the effect that "in most cases from the very onset of the disease until death, which may occur weeks or even months later, the animal may never cease to eat all the food placed before it, and in numerous cases under my own observation the bedding has been devoured during the hours of the night, the temperature at the time being 41·2°C. (106·1°F.) or even as high as 42°C. (107·6°F.). Evans remarks: "Some cases at last drop down, and die suddenly, perhaps when they are eating and enjoying their food.....while other cases linger for days after they are down, too weak to rise or to stand after

* Vol. I, Surra Report.

they are helped up, but go on eating all the grass they get and much of the corn until they die." Again Steele remarks : "The appetite is excessive throughout the attack ; it is remarkable how the animal in a state of semi-coma will continue to eat grass almost without ceasing.....Some patients stand and feed to the very last, and then drop dead."

Exceptions to this rule, however, must occur, for in September 1896, the water-famine year, I was asked to investigate a new disease which was carrying off a number of horses belonging to the Rohilkhund and Kamaon Railway Company, the most marked symptoms of which were *loss* of appetite, fever, emaciation, &c. On remarking that it must be the old disease the animals were succumbing to, for it was then September, the height of the Surra season in that part of India, I was definitely informed by the Superintendent, a man with 40 years' experience of horses in this country, that the malady from which the animals suffered was a totally new disease. The reason assigned being that the first symptom noted was loss of appetite followed by fever ; "every one knew that a Surra horse never left off feeding, but that his appetite increased rather than diminished as the disease progressed." Within a period of 24 hours after my arrival, the blood of all the horses on the Dák line had been examined microscopically, and 33 found to contain the Surra hæmatozoon in varying numbers. Out of a total of 101 horses, 92 succumbed to Surra. From the instance above cited it will be seen that occasionally *Anorexia* may be a marked symptom of this disease instead of the ravenous appetite frequently observed.

SECTION VI.

Treatment of Horse Surra.

On reference to Volume I, Surra Report, it will be observed that the methods of treatment made use of included—

A. Rational therapeutic remedies.—The following chemicals were selected, and administered as being the most likely to effect a destructive action on the hæmatozoon :—

(i) Mercurie Perchloride.
(ii) Iodine and Iodide of Potassium.
(iii) Potassium Bichromate.
(iv) Iodoform.
(v) Oleum Terebinthinæ.
(vi) Carbolic Acid in conjunction with Iodine.
(vii) Cinchona Alkaloids and Arsenic.
(viii) Double Iodide of Potassium and Mercury.
(ix) Quinine Sulphate.
(x) Liquor Potassæ.
(xi) Arsenic.

It will be seen from the accompanying table of treatment that the first results were obtained by the employment of the mixture of Cinchona Alkaloids and Arsenic, *vide* cases LXV and LXXII. In the former the hæmatozoon disappeared after six days of treatment and remained absent for a period of 27 days. But it was found that after the drugs had been administered for 26 days, symptoms of gastric irritation appeared, which were due to the alkaloids ; and consequently this form of treatment had to be discontinued just at a critical stage of the experiment.

Arsenic alone had still more favourable results as regards the destruction of the hæmatozoon, as will be seen in the following table :—

Horse Number.	Days of treatment to disappearance of hæmatozoon.	Amount of Arsenic to date of disappearance.	Number of days hæmatozoon absent.
		Grains.	
LXXVII	8	82	56
LXXVI	5·5	56	27
LXXX	2	12	44
LXXXII	2	16	64
LXXIII	3·5	41	84

In the above cases the cause of death was usually Arsenical poisoning, and this was owing to the fact that great difficulty was experienced in determining the length of period for which the chemical should be administered. It will be remembered that to prove the absence of the Surra organism from the blood, other animals have to be inoculated from the animal under treatment.

In the ordinary cases of Surra, where no treatment has been adopted, the latent period, when Guinea Pigs are inoculated, is only about one week ; but when the fluid for inoculation is taken from an animal that has been subjected to prolonged Arsenical treatment, the latent period is extended to about three weeks, and this time must elapse before the question can be decided. During this period the administration of Arsenic has to be continued, hence the animal may receive far more than is necessary for the total destruction of the organism.

Such results have been obtained from no other form of treatment, and it will be all-important to determine to what degree the administration of Arsenic can be safely carried, for it is well known that no satisfactory results can be obtained without first producing the full physiological effects of the drug.

Table No. XVII—Treatment.

Horse Number.	Treatment.	How administered.	Minimum dose.	Maximum dose.	Total quantity of each drug administered in		Date. From—To. Under each form of treatment.	Number of days under form of treatment.	Date of disappearance of hæmatozoa from the blood.	Date of re-appearance of hæmatozoa in the blood.	Number of days hæmatozoa absent.	Result of treatment.	Number of days which elapsed between the first appearance of disease and death.	Number of days under treatment for Surra.
					Grains.	Grammes.								
VI	Hydrargyri Perchloride.	Subcutaneously injected.	2·3 grains, 0·15 grammes.	10·8 grains, 0·7 grammes...	40·1	2·60	3rd Dec. 1890 ... to 8th Dec. 1890 ...	6	2nd Dec. 1890 ...	5th Dec. 1890 ...	3	Nil ...	44	16
	Iodine	Injected into Trachea.	1·8 grains, 0·11 grammes.	5·5 grains, 0·35 grammes.	37·49	2·43	9th Dec. 1890 ... to 18th Dec. 1890 ...	10	13th Dec. 1890 ...	14th Dec. 1890...	1	Death ...		
	Potassium Iodide...		8·8 grains, 0·56 grammes.	26·5 grains, 1·7 grammes.	187·49	12·15								
VIII	Iodoform in Æther.	Subcutaneously injected.	3 grains, 0·19 grammes.	4 grains, 0·25 grammes ...	7	0·45	30th Dec. 1890 ... to 31st Dec. 1890 ...	2	28th Dec. 1890 ...	31st Dec. 1890 ...	3	Nil ...	18	6
	Do. ...	Injected into Jugular vein.	5 grains, 0·32 grammes.	25 grains, 0·16 grammes...	44	2·85	1st January 1891. to 3rd January 1891.	3	.....	.....	...	Nil ...		
	Hydrargyri Perchloride.	Do. ...	9·25 grains, 0·6 grammes.	9·25 grains, 0·6 grammes.	9·25	0·6	4th January 1891...	1	.....	.....	...	Death ...		
XIV	Oleum Terebinthinæ.	Subcutaneously injected.	8 c.c.	8 c.c.	...	...	9th February 1891.	1	.....	.....	...	Nil ...	21	5
	Do. ...	Injected into Jugular vein.	8 c.c.	8 c.c.	...	...	10th February 1891.	1	.....	.....	...	Nil ...		
	Do. ...	Injected into Trachea.	8 c.c.	12 c.c.	...	...	14th Feb. 1891 ... to 16th Feb. 1891 ...	3	.....	.....	...	Death ...		
XV	Potass Bichromate..	Injected into Jugular vein.	5 grains, 0·32 grammes ...	11 grains, 0·71 grammes...	23·5	1·52	7th Feb. 1891 ... to 10th Feb. 1891 ...	4	.....	.....	...	Nil ...	35	20
	Do. ...	Gastric ingestion.	40 grains, 2·59 grammes.	180 grains, 11·65 grammes.	2,378·5	154·12	13th Feb. 1891 ... to 28th Feb. 1891 ...	16	22nd Feb. 1891... to 27th Feb. 1891 ...	24th Feb. 1891... to 4th Mar. 1891 ...	2 to 5	Death ...		
LXV	Mixed Cinchona Alkaloids.	Do. ...	30 grains, 1·94 grammes.	180 grains, 11·65 grammes.	7,680	497·66	14th June 1892... to 9th July 1892 ...	26	20th June 1892 ...	17th July 1892...	27	Nil ...	67	29
	Arsenic		4 grains, 0·25 grammes.	12 grains, 0·77 grammes.	427	27·6	17th July 1892 ... to 19th July 1892 ...	3	21st July 1892 ...	.....	9	Death ...		
LXX	Acid, Carbolic ...	Do. ...	60 grains, 3·88 grammes.	120 grains, 7·77 grammes.	4,560	295·48	25th Sept. 1892... to 30th Sept. 1892...	6	27th Sept. 1892... to 1st October 1892.	28th Sep. 1892... 4th Oct. 1892 ...	1 to 3	Nil ...	26	21
	Iodine		30 grains, 1·94 grammes.	30 grains, 1·94 grammes...	2,070	134·13								
	Mixed Cinchona Alkaloids.	Do. ...	90 grains, 5·83 grammes.	180 grains, 11·65 grammes.	4,230	274·10	4th Oct. 1892 ... to 18th Oct. 1892 ...	15	8th Oct. 1892 ... to 16th Oct. 1892 ...	10th Oct. 1892	2 to 4	Death ..		
	Arsenic		5 grains, 0·32 grammes.	8 grains, 0·51 grammes ...	181	11·08								
LXXI	Mixed Cinchona Alkaloids.	Do. ...	60 grains, 3·88 grammes.	180 grains, 11·65 grammes.	7,920	513·21	25th Sept. 1892... to 26th Oct. 1892 ...	32	26th Sept. 1892 .. to 16th Oct. 1892 ...	1st Oct. 1892 ... 14th Oct. 1892...	5 to 12	Death ...	34	32
	Arsenic		4 grains, 0·25 grammes.	7 grains, 0·45 grammes ...	355	23·004								

Table No. XVII (continued).

XXII	Mixed Cinchona Alkaloids.	Gastric ingestion.	180 grains, 11·65 grammes.	180 grains, 11·65 grammes.	1,620	104·97	12th Oct. 1892 ...	5	.. ...	.....	...	Nil ...				
	Arsenic		4 grains, 0·25 grammes..	6 grains, 0·38 grammes ...	44	2·85	6th Oct. 1892 ...									
	Quinæ : Sulphate...	Do. ...	240 grains, 15·55 grammes.	360 grains, 23·32 grammes.	1,080	128·3	17th Oct. 1892 ...	6	18th Oct. 1892 ...	19th Oct. 1892...	1	Nil ..	45	34		
	Arsenic		6 grains, 0·38 grammes ...	6 grains, 0·38 grammes ...	72	4·66	22nd Oct. 1892 ...									
	Mixed Cinchona Alkaloids.	Do. ...	120 grains, 7·77 grammes.	180 grains, 11·65 grammes.	6,780	439·34	23rd Oct. 1892 ...	23	24th Oct. 1892 ...	19th Nov. 1892...	26	Death ...				
	Arsenic		4 grains, 0·25 grammes .	8 grains, 0·51 grammes ...	257	16·005	14th Nov. 1892...									
LXXIII	Iodic Hydrargyri...	Do. ...	2 grains, 0·13 grammes .	6 grains, 0·38 grammes ...	214	13·8	31st Oct. 1892 ..	22	5th Nov. 1892 ...	15th Nov. 1892 .	10	Nil ...	110	109		
							22nd Nov. 1892...		17th Nov. 1892 ...	22nd Nov. 1892..	5					
	Arsenic		3 grains, 0·19 grammes .	7·5 grains, 0·48 grammes .	795	51·51	22nd Nov. 1892...	87	26th Nov. 1892 ...	.....	84	Death ...				
							16th Feb. 1893 ...									
LXXIV	Santonin	Do. ...	30 grains, 1·94 grammes.	30 grains, 1·94 grammes .	60	3·88	10th Nov. 1892...	2	.....	.....	...	Nil ...	38	31		
							11th Nov. 1892...									
	Iodic Hydrarg. ...		4 grains, 0·25 grammes .	6 grains, 0·38 grammes ...	56	3·62	16th Nov. 1892...	6	.....	19th Nov. 1892 .	3	Nil ...				
							21st Nov. 1892 ...									
	Quinine		180 grains, 11·65 grammes.	180 grains, 11·65 grammes.	540	34·95	15th Nov. 1892...	...	16th Nov. 1892 ...	19th Nov. 1892 .	3	Nil ...				
							20th Nov. 1892...									
							21st Nov. 1892 ...									
	Arsenic		5 grains, 0·32 grammes .	6 grains, 0·38 grammes ...	274	17·75	22nd Nov. 1892...	23	23rd Nov. 1892 ...	27th Nov. 1892..	4	Death ...				
							14th Dec. 1892 ...		28th Nov. 1892 ...	15th Dec. 1892...	18					
LXXVI	Potassæ Hydrate...	Do. ...	54 grains, 3·507 grammes.	17·5 grains, 1·333 grammes.	220·75	14·304	26th Nov. 1892...	6	27th Nov. 1892 ..	28th Nov. 1892 .	1	Nil ...	40	38		
							1st Dec. 1892 ...									
	Arsenic		3 grains, 0·19 grammes..	7 grains, 0·45 grammes ...	313	20·28	3rd Dec. 1892 ...	32	9th Nov. 1892 ...	.....	27	Death ...				
							3rd Jan. 1893 ...									
LXXVII	Arsenic	Do. ...	4 grains, 0·25 grammes ...	6·5 grains, 0·42 grammes	560	36·23	30th Nov. 1892...	57	3rd Dec. 1892 ...	6th Dec. 1892 ...	3	Death ...	65	57		
							26th Jan. 1893 ...		8th Dec. 1892 ...	3rd Jan. 1893 ...	26					
									4th January 1893.	5th Jan. 1893 ...	1					
									7th January 1893.	22nd Jan. 1893...	15					
LXXVIII	Arsenic	Do. ...	4 grains, 0·25 grammes ...	6 grains, 0·38 grammes ...	116	7·51	7th Dec. 1892 ...	11	11th Nov. 1892 ...	.....	7	Death ...	12	11		
							17th Dec. 1892 ...									
LXXIX	Arsenic	Do. ...	4 grains, 0·25 grammes ...	6 grains, 0·38 grammes ...	177	11·46	7th Dec. 1892 ...	16	10th Dec. 1892 ...	.....	13	Death ...	16	16		
							22nd Dec. 1892...									
LXXX	Arsenic	Do. ...	3 grains, 0·19 grammes ..	6 grains, 0·38 grammes ...	427	27·66	11th Dec. 1892 ...	45	13th Dec. 1892 ...	.....	44	Death ...	46	45		
							24th Jan. 1893 ...									
LXXXI	Arsenic		3 grains, 0·19 grammes .	7·5 grains, 0·48 grammes .			23rd Dec. 1892 ...	17	25th Dec. 1892 ...	26th Dec. 1892...	1	Nil ...				
							8th Jan. 1893 ...		29th Dec. 1892 ...	2nd Jan. 1893...	4					
	(i) ...	Do. ...	5 grains, 0·32 grammes.	7·5 grains, 0·48 grammes .	274	17·75	11th Jan. 1893 ...	10	14th January 1893.	19th Jan. 1893 ...	5	Nil ...	41	30		
	(ii) ...						20th Jan. 1893 ...									
	(iii) ...		5 grains, 0·32 grammes..	5 grains, 0·32 grammes ...			24th Jan. 1893 ...	3	24th January 1893.	25th Jan. 1893...	1	Death ...				
							26th Jan. 1893 ...									
LXXXII	Arsenic	Do. ...	3 grains, 0·19 grammes ...	6·5 grains, 0·42 grammes .	525	34·02	23rd Dec. 1892 ...	57	25th Dec. 1892 ...	.....	64	Death ...	70	57		
							17th Feb. 1893 ...									
LXXXIV	Arsenic	Do. ...	4 grains, 0·25 grammes ...	4·5 grains, 0·29 grammes .	55	3·56	28th Jan. 1893 ...	6	28th January 1893.	8th Feb. 1893 ...	11	Death ...	17	6		
							2nd Feb. 1893 ...									

B.—The subcutaneous injection of blood and its derivatives, in its different forms, obtained from animals suffering from, or which had lately succumbed to, Surra.

(*a*) Serum from blood (containing swarms of Surra hæmatozoa) after being passed through a porcelain filter.

(*b*) The injection of proteids dissolved in glycerine and water after precipitation from live Surra blood.

(*c*) Subcutaneous injection of blood obtained from an animal of the bovine species, recently the subject of Surra, but which, after a second inoculation of virulent material, was proved protected against the disease.

The subsequent experiments with regard to the treatment of Surra will be treated of under the following headings :—

I.—*Treatment after Surra has declared itself.*

(i) Naturally acquired or spontaneous Surra.

(ii) Animals inoculated by gastric ingestion of soiled blood.

II.—*Preliminary Treatment and subsequent inoculation.*

(i) By Arsenic in the form of Liquor Arsenicalis.

(ii) By the Double Iodide of Arsenic and Mercury.

I.—Treatment after Surra has declared itself.

(i) *Naturally acquired or Spontaneous Surra.*

Under this head twenty-one horses suffering from Surra were submitted to the Arsenical treatment ; fifteen were known to have suffered from the disease for periods varying from ten to thirty-five days, previous to their admission to the Laboratory Hospital. Of the above fifteen animals, six failed to survive for more than a fortnight after the treatment was commenced, owing to their weak condition, brought about by the paroxysms of fever they had previously passed through.

In three of the twenty-one cases the hæmatozoon re-appeared in the blood after an absence of 28, 2 and 70 days respectively, but in the case of Horse CXVII, in which the organisms re-appeared after two days, a sufficient reason is patent to account for its recurrence ; in that the Arsenic was first administered just before the termination of an intermission, and a sufficient quantity of the drug had not been given to destroy the developing *Trypanosoma* previous to the recurrence of a fresh paroxysm.

In the blood of two horses Nos. CXXII and CXXIII, the hæmatozoon appeared a second time after the animals had been submitted to the Arsenical treatment, and it is of interest to observe that in both the first recurrence took place after intermissions of 52 and 50 days, whilst the second recurrence occurred after intermissions of 50 and 30 days respectively :—

Appendix No.	Laboratory No.	Owner's No.	Owners in Bombay.	Breed.	Sex.	Age.	Animal stationed at.	Date on which the animal was first observed to be ailing.	Date on which Hæmatozoon was discovered in the blood.	Date on which animal was admitted to the Laboratory Hospital.	Total days which elapsed between ailing of animal and admission.	Date on which animal was submitted to Arsenical treatment.	Date on which Hæmatozoon disappeared from the blood after treatment commenced.	Date of first return of Hæmatozoon after treatment.	Length of first Intermission in days.	Date of second return of Hæmatozoon after treatment.	Length of second Intermission in days.	Animal under Arsenical treatment in days.	Quantity of Arsenic administered in grains.	Result, Cure or Death.	Date of Result.	Remarks.
I	CIV	445	Tramway Company.	Australian	Mare	11	Bombay	7th Aug. 1894.	9th Aug. 1894.	13th Aug. 1894	7	14th Aug. 1894	18th Aug. 1894	.....	31	.....	.....	35	235	Death	17th Sept. 1894	
	CVI	...	Private	C. Bred ...	Entire ...	Aged.	Do. ...	3rd Aug. 1894	?	7th Sep. 1894.	35	7th Sept 1894.	9th Sept. 1894	.....	Few hours	.....	.....	1·5	12	,,	9th Sept. 1894	
	CVII	536	Tramway Company.	Australian	Gelding	14	Do. ...	23rd Sep. 1894.	23rd Sept. 1894.	25th Sep. 1894.	3	25th Sept 1894.	29th Sept. 1894	.....	6	.....	.....	10	52	,,	4th Oct. 1894	
	CVIII	...	Private	Arab ...	Entire ...	6	Do. ..	3rd Sep. 1894.	26th Sept. 1894	Do. ...	23	27th Sept 1894.	Do. ...	.....	53	.....	.....	55	370	,,	20th Nov. 1894	
	CIX	...	Inspector Police	Persian ...	Do. ...	9	Mahim...	7th Oct. 1894.	11th Oct. 1894	5 th Nov. 1894.	30	5th Nov. 1894.	10th Nov. 1894	.....	66	.....	.....	68	561	,,	15th Jan. 1895	
	CX	27	Mounted Police ...	Do. ...	Do. ...	9	Bombay	17th Oct. 1894.	20th Oct. 1894.	Do. ...	20	Do. ...	9th Nov. 1894	.....	43	.....	.....	50	321	,,	21st Dec. 1894	
	CXI	100	Do. ...	Do. ...	Do. ...	5	Mahim...	Do. ...	20th Oct. 1894.	Do. ..	20	Do. ...	10th Nov. 1894	8th Dec. 1894	28	.....	.....	53	408	,,	26th Dec. 1894	
	CXII	61	Tramway Company.	Do ...	Gelding	13	Bombay	31st Oct. 1894.	7th Nov. 1894.	9th Nov. 1894.	10	9th Nov. 1894	12th Nov. 1894	.....	73	.....	.....	76	539·5	,,	24th Jan. 1895	
	CXIII	41	Mounted Police...	Do. .	Entire ...	5	Do. ..	1st Nov. 1894.	8th Nov. 1894.	29th Nov. 1894	29	29th Nov, 1894	3rd Dec. 1894	.....	11	.....	.....	15	135·5	,,	13th Dec. 1894	
	CXIV	58	Do. ..	Australian	Do. ...	5	Do. .	17th Nov. 1894	22nd Nov. 1894	Do. ...	13	Do. ...	2nd Dec. 1894	.....	11	.....	.....	14	92·5	,,	12th Dec. 1894	
	CXV	86	Do. ...	Persian ..	Do. ...	5	Do. ...	16th Nov. 1894	23rd Nov. 1894.	Do. ...	14	Do. ...	4th Dec. 1894	.....	...	.....	.....	63	455·0	Cured	30th Jan. 1895	
	CXVI	388	Tramway Company.	Australian	Gelding	11	Do. ..	17th Oct 1894.	29th Nov. 1894	1st Dec. 1894.	16	1st Dec. 1894.	3rd Dec. 1894	.....	12	.....	.....	14	115·5	Death	17th Dec. 1894	
	CXVII	502	Do. ...	Do. ...	Do. ...	9	Do. ...	29th Nov. 1894	29th Nov. 1894	Do. ...	3	Do. ...	2nd Dec. 1894	4th Dec. 1894	2	.....	.....	17	114·5	,,	Do. ...	
	CXVIII	128	Do. ...	Do. ...	Do. ..	16	Do. ..	3rd Dec. 1894.	9th Dec. 1894.	5th Dec. 1894.	3	5th Dec. 1894.	6th Dec. 1894	.....	25	.....	.....	26	150·5	,,	30th Dec. 1894	
	CXIX	822	Do. .	Herati ...	Do. ...	8	Do. ...	Do. ...	4th Dec. 1894	6th Dec. 1894.	4	6th Dec. 1894.	8th Dec. 1894	16th Feb. 1895	70	.....	.....	208	2,159	..	2nd July 1895	
	CXX	53	Mounted Police...	Persian ...	Entire ...	7	Do. ...	27th Nov. 1894.	4th Dec. 1894.	10th Dec. 1894.	14	10th Dec. 1894.	12th Dec. 1894	.....	34	.....	.....	37	198	,.	14th Jan. 1895	
	CXXI	91	Do. ...	Do. ..	Do. ...	5	Do. ..	19th Nov. 1894.	3rd Dec. 1894.	Do. ..	22	Do. ...	11th Dec. 1894	.....	14	.....	.....	15	118	,,	24th Dec. 1894	
	CXXII	96	Do. ...	Do. ...	Do. ...	6	Do. ...	20th Nov. 1894.	18th Nov. 1894	Do. ...	21	Do. ...	14th Dec. 1894	4th Feb. 1895	52	26th Mar, 1895	49	135	814	..	24th Apr. 1895	
	CXXIII	29	Do. ...	Do. ...	Do. ...	6	Do. ...	14th Nov. 1894.	7th Dec. 1894.	23rd Dec. 1894	40	23rd Dec. 1894.	25th Dec. 1894	13th Feb. 1895	50	15th Mar. 1895	29	83	580	,,	15th Mar. 1895	
	CXXIV	93	Do. ...	Do. ...	Do. ...	7	Do. ...	7th Dec. 1894.	Do. ...	Do. ..	17	Do. ...	26th Dec. 1894	.....	45	.....	.....	48	389·5	,,	8th Feb. 1895	
	CXXV	?	Tramway Company.	Do. ...	Gelding	Aged.	Do. ...	27th Jan 1895. Gastric ingestion of blood.	28th Jan. 1895	30th Jan. 1895.	4 Latent Period.	30th Jan. 1895.	31st Jan. 1895	.....	4	.....	.....	6	44	,,	4th Feb. 1895	
II	LXXXIX	...	.....	Australian	Do. ...	Do....	Poona ...	24th Nov. 1893.	1st Dec. 1893.	.....	7	1st Dec. 1893.	6th Dec. 1893	.....	...			*65 †106	458 1822 c. c.	Cured	3rd Feb. 1894	
	XCVI	...	.....	C. Bred ...	Entire ...	Do....	Do. ...	18th Oct. 1893. Subcut. inoculation of blood.	26th Oct. 1893.	.....	8	26th Oct. 1893. Preliminary treatment.	31st Oct. 1893	.....	...	.....	.....	16	178	Death	11th Nov. 1893	
III	XCVIII	...	.....	Australian	Mare ...	Do....	Do. ...	21st May 1894.	27th May 1894	.....	6	28th Mar. 1894. 30th May 1894.	1st June 1894	6th June 1894	6	17th June 1894	5	*58 †32 †104	351·25 188·8 c. c. 2196·8 c. c.	,,	16th July 1894	5 paroxysms in all 1·44 grammes of Vasicine given 25th June 1895.
	XCIX	..	.....	Do. ...	Gelding	Do....	Do. ...	Do. ...	26th May 1894.	.....	5	5th Apr. 1894.	29th May 1894	30th May 1894	1	6th June 1894	4	*25	107·5 grs.	,,	24th July 1894	7 paroxysms in all.
	CIII	...	.....	C. Bred ...	Do. ...	Do....	Wai ...	27th July 1894.	29th July 1894.	.....		29th June 1894.	.....	.....	...	.....	.....	33	1074 c. c.	,,	1st Aug. 1894	

* Arsenic as Liq. Arsenicalis, † Double Iodides of Arsenic and Mercury.

It has previously been noted that the most common periods during treatment by Arsenic, in which the hæmatozoon re-appears in the circulation of equines, whose systems are under the influence of the drug, is somewhere about the 25th, 50th or 75th day of an intermission, *i.e.*, subsequent to the disappearance of the organism from the circulation of the animal. This gives one an idea of the deterrent effect produced on the immature form of the Surra hæmatozoon, and its great tenacity of life, for in ordinary cases of Surra the intermissions between the paroxysms, rarely if ever, exceed a maximum duration of seven days.

No. CXV, a Persian Gulf entire horse, aged 4 years, belonging to the Bombay Mounted Police. It was seized with fever (temperature 105°F.) in the middle of October 1894. This animal was purchased on the 16th July 1894, and Surra was diagnosed on the 23rd November 1894; there is, therefore, no doubt that the disease was contracted in Bombay. The horse was sent to the Poona Laboratory on November 29th, and the same evening the Arsenical Treatment was commenced, *i.e.*, the 21st day of the disease, just at the termination of an intermission, probably the second. The hæmatozoon was present in the blood whilst under observation from the 22nd to the 25th day of the disease, but after the latter day did not recur; but two days later an urticarial eruption, involving the under-surface of the abdomen and thighs, appeared and persisted for 24 hours. In all 455 grains of Arsenic were administered in sixty-three days, after which Sodium Iodide in two-drachm doses was continued twice daily for seventy-two hours. The animal made an uninterrupted recovery, and was returned from Poona to the Mounted Police, Bombay, on 9th March 1895, cured. Two days later a Board there examined and reported 'that the animal was sound and healthy, and certified it fit for duty.' A letter received from the Commissioner of Police, Bombay, 3rd January 1898, states 'that the horse is still alive, and in good health and condition,' three years and two months after the attack of Surra.

TABLE No. XIX.

Horse CXV.—Entire, Persian, aged 4 years, Cured.

Day of Month.	Day of Disease.	Day of Treatment.	Total amount of Arsenic up to date.	Amount to date of Sodium Iodide and Potass-Nit.	Red blood Corpuscles.	White blood Corpuscles.	Coarsely granular Cells.	Remarks.
1894.			Grs.					
December 4th ...	26th	6	38	...	8,440,000	17,800	800	
„ 12th ...	34th	14	127	...	8,280,000	9,600	1,000	
„ 21st ...	43rd	23	217	...	8,100,000	5,600	400	40th day Temp. 103·3° F. 39·6° C.
„ 30th ...	52nd	32	277	...	7,640,000	9,400	600	
1895.								
January 9th ...	62nd	42	357	...	8,720,000	9,400	800	
„ 19th ...	72nd	52	427	...	7,130,000	8,800	800	
„ 28th ...	81st	61	465	...	9,480,000	10,000	600	
February 5th ...	89th	69	473	xvi.	9,300,000	9,200	600	
„ 14th ...	98th	78	...	KNO_3 iv.	8,750,000	9,800	400	
„ 22nd ...	106th	86	...	xiv.	8,250,000	8,200	80	
March 3rd ...	115th	95	...	...	8,160,000	6,400	200	5th crystals of hæmoglobin in the blood.
„ 9th ...	121st	101	...	...	7,990,000	7,400	340	Cured.

The second case under this heading, Horse No. CXIX., lived for 209 days after the hæmatozoon appeared in the blood. The animal was under treatment for the same period, during which time it lost flesh, but later regained it, and weighed 11 maunds or 904 lbs. Hopes were entertained of being able to save this animal, but on the 16th May, the establishment of the Laboratory were removed to Muktesar, North-Western Provinces, 1,120 miles distant from Bombay. So this animal was left at the Sangam Veterinary Hospital under the charge of the Veterinary Graduate in charge. Unfortunately the telegraph was not at that time connected with Muktesar, and telegrams were frequently not delivered at their destination for 4 or 5 days after being despatched, consequently instructions wired as to the treatment of the animal were useless. Arsenic to the amount of 2,239 grains was administered to the animal during 209 days, equal to a daily dose of 10·71 grains; death resulted from Chronic Arsenical poisoning.

The following table shows the number and ratios of the corpuscular constituents of the blood of Horse No. CXIX during the period it was subjected to treatment, and the amount of the drug administered:—

TABLE No. XX.

Horse No. CXIX.—Herati gelding, aged 8 years. Surra diagnosed 4th December 1894.

Day of Month.	Day of Disease	Day of Treatment.	Total amount of Arsenic up to each date.	Red blood Corpuscles 1 c.mm.	White blood Corpuscles 1 c.mm.	Coarsely Granular Corpuscles 1 c.mm.	Ratio White to Red Corpuscles.	Ratio Coarsely Granular to White Corpuscles.	Ratio Coarsely Granular to Red Corpuscles.	Hæmatozoa in 1 c.mm.
1894.			Grains.							
December 6th...	4	1st	...	7,400,000	10,000	...	1 : 740	...	...	5,600
„ 14th...	12	9th	52	7,910,000	9,600	50	1 : 824	1 : 192	1 :158,200	Absent.
„ 23rd...	21	18th	147	8,070,000	7,800	600	1 : 1,034	1 : 13	1 : 13,450	...
„ 31st...	29	26th	208	7,860.000	3,600	600	1 : 2,183	1 : 6	1 : 13,100	...
1895.										
January 9th...	38	35th	334	7,970,000	4,400	800	1 : 1,811	1 : 5	1 : 9,962	...
„ 18th...	47	44th	415	9,960,000	8,600	1,000	1 : 926	1 : 8	1 : 7,960	...
„ 26th...	55	52nd	463	6,200,000	3,800	200	1 : 1,631	1 : 19	1 : 31,000	...
February 3rd...	63	60th	501	6,740,000	4,800	200	1 : 1,404	1 : 24	1 : 33,700	...
„ 11th...	71	68th	527	6,680,000	5,800	130	1 : 1,152	1 : 44	1 : 51,384	...
„ 19th...	79	76th	563	6,200,000	11,200	70	1 : 620	1 : 160	1 ; 88,571	1,960
„ 27th...	87	84th	655	6,940,000	5,800	...	1 : 1,196	...	...	Absent.
March 9th...	97	94th	670	6,500,000	12 200	...	1 : 533	...	...	...
„ 18th .	106	103rd	772	7,930,000	5,600	...	1 : 1,416	...	...	...
„ 26th...	114	111th	772	5,420,000	7,000	400	1 : 774	1 : 17	1 : 13,550	...
April 3rd...	122	119th	790	6,640,000	3,800	200	1 : 1,747	1 : 19	1 : 33,200	...
„ 12th...	131	128th	868	8,350,000	9,800	20	1 : 852	1 : 490	1 :417,500	...
„ 23rd..	142	139th	957	7,500,000	9,600	...	1 : 781	...	...	...
July 2nd...	212	209th	2,119	Death	occurred.					736

(ii) Animals inoculated by Gastric ingestion of soiled blood.

Two horses, an Australian and a Country-Bred, both aged animals, were utilized in this experiment. Surra was communicated to them by the gastric ingestion of soiled blood. When the hæmatozoon became manifest, the animals, within a period of 24 hours, were submitted to a treatment consisting of Arsenic in increasing doses, in the form of Liquor Arsenicalis. The Country-Bred succumbed to Surra on the 16th day of the disease, after a total of 178 grains of Arsenic had been administered, but the Australian recovered, and after a period of 15 months was utilized for a further experiment. The following is a short account of the case:—

Horse No. LXXXIX.—An Australian gelding, aged, was sent, in company with Horse No. XCI, to the Veterinary College Hospital, Parel, for the purpose of testing whether Surra could be communicated by gastric ingestion of rat's excrement with corn. The experiment was commenced on May 6th, 1893, and continued until September 26th, 1893, when the animal was returned to Poona, not having contracted the disease. As Horse No. XCI, which had been subjected to the same treatment, developed Surra the day after its arrival in Poona, the blood of No. LXXXIX was microscopically examined, and the temperature, pulse and respiration recorded daily, in order to observe whether the animal would eventually develop any symptoms. As, however, the animal remained in good health up to 24th November, four ounces of blood containing swarms of hæmatozoa, taken from the heart of Horse No. XCVII, immediately after death, were administered by gastric ingestion, at 3 P. M. on the above date. The latent period occupied six and a half days. Treatment was commenced within some hours, consisting of Arsenic in grain iv doses, increasing rapidly to twelve grains daily. After a paroxysm lasting 5 days, during which period the hæmatozoa were very numerous, they disappeared from the blood. The Arsenical treatment was continued for sixty-five days, 454 grains of Arsenic being administered. At this period of the case the animal showed an aversion to the Arsenic in this form. For this reason, and as previous experience pointed to the fact that this chemical by itself did not in some cases destroy the resting or immature form of the hæmatozoon, the Double Iodide of Arsenic and Mercury was substituted, as it was known that the Iodide of Mercury does not form an albuminate, and consequently the whole of the salt would be available. The Iodides were continued for a period of 106 days, in order to ensure the absolute destruction of the immature form. In all 1,822·75 c. c. or 288 grains each of the Tri-iodide of Arsenic and Bin-iodide of Mercury were given. Thirty-three weeks after the medicine had been discontinued the animal was in good health and condition, and no hæmatozoa had appeared in the circulation for 423 days or over 15 months. For six and a half months during this period the animal averaged four and a half miles walking exercise daily. As the animal did not thrive on gram, barley (boiled) was given in its place, with the most satisfactory results; the horse rapidly put on flesh. At a later date this animal was utilized to discover whether one attack of Surra protects against a second attack of the same disease.

Does one attack of Surra protect a horse against a second attack of the same disease.

An Australian Gelding, the subject of Surra in December 1893, was cured of this disease by the administration of Arsenic and Iodide of Arsenic and Mercury.

Between March and October 1894 the animal gained 235·75 lbs. in weight, and was in a perfect state of health and condition. Fifteen months after the date of the previous attack, and twelve months after the cure was effected, the animal was inoculated with a minute drop of Surra blood, a mere trace of soiled blood being smeared over a scratch on the muzzle, in order to ascertain whether any immunity had been conferred by the previous attack. The latent period of the second attack occupied seven days. The progress of the disease was marked, as usual, by paroxysms of fever and intermissions, lasting 52 days. There were three paroxysms occupying 5, 20 and 22 days, and two intermissions lasting 3 and 2 days respectively. From this it will be observed that the lengths of the 2nd and 3rd paroxysms were considerably modified, while the presence of the hæmatozoon in the periods was most erratic; one day, on examination of the blood, one in a field of the microscope would be found, whereas on the next day probably only one in a cover-glass preparation.

Death took place on the 53rd day of the disease, clearly proving that one attack of Surra is unable to protect against a second attack.

Notes for guidance in the treatment of Surra in Equines.

Only animals in good or in fairly good condition are suitable to undergo treatment for Surra. It will be found impracticable to attempt to cure ill-preserved animals, such as Tonga-ponies, towards the end of a heavy and hard-worked season.

2. It is of the utmost importance for the successful treatment of Surra that the disease be recognized, and the animal subjected to the drug with the least possible delay.

3. The weight of the animal should be ascertained frequently when practicable, so that the maximum dose of Arsenic to be administered during the treatment may be regulated.

4. Arsenic should be given in the form of Liquor Arsenicalis (Fowler's solution).

Arsenious Acid (in powder)	87 grains.
Carbonate of Potassium...	87 „

add half a pint of distilled water to these in a flask and heat till dissolved: cool and add *Compound Tincture of Lavender 5 drachms, Distilled water sufficient to make one pint.

5. In most cases of Surra in equines a dose of five grains (5 grs.) may be commenced with, and given twice daily for forty-eight (48) hours, the quantity being increased by half a grain after every four (4) doses have been administered, until seven (7) grains are reached. The latter amount should be continued twice daily for seven (7) days in the case of an animal below eight-hundred (800) pounds in weight, but in Australians of one-thousand (1,000) pounds in weight and upwards, the dose may be increased by the addition of half a grain up to nine (9) or even ten (10) grains, twice daily for the same period. The dose should then be gradually reduced by half a grain or one grain according to the condition of the patient, until a four (4) grain dose has been reached. Again, if possible, after a period of two days, repeat the treatment increasing and decreasing the dose of Arsenic as above described. But the fact must never be lost sight of, that if Arsenic be administered to an animal for a prolonged period, symptoms of gastric irritation will supervene sooner or later. It has been found that by giving †*kaunji* to the animal, morning and evening directly after the medicine, the above-mentioned symptoms have not made their appearance; consequently, it would be advisable to give kaunji to the animals from the commencement of the Arsenical treatment.

6. Daily microscopic observations of the blood should be made, and the number of organisms recorded on a chart for ready reference, together with the temperature, pulse and respirations of the patient, which should be taken three times daily, viz., 8 A.M., 1 P.M. and 5 P.M.

7. Most animals will take the drug in one to two pints of water from a bucket, without any trouble. If this be found occasionally impracticable, the Arsenic can be mixed with the corn and bran in the form of Liquor Arsenicalis; but in obstinate cases the medicine will have to be administered to the animal in the form of a bolus or in a draught.

8. Acute Desquammative Nephritis is a common complication of Surra, but it must not contra-indicate the administration of Arsenic, although the maximum doses cannot be maintained, otherwise the animal will have a relapse, and ultimately succumb to the disease.

9. Animals suffering from Surra, as a general rule, have voracious appetites. It has been found by practical experience that the following amounts of hay, corn, &c., are necessary for an Australian horse weighing 1,000 lbs. and over; for on this the animal keeps in fair condition and during convalescence puts on flesh rapidly—

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* The Compound Tincture of Lavender may be omitted, but the animals under treatment take the medicine more readily when it is present.

† Linseed, Rice—ā ā ½ lb. Add water a sufficiency. Boil for ¾th hour and give when cool.

Hay, 15 to 20 lbs. Lucerne (fresh), 10 lbs. *Barley, 8 to 14 lbs. or Gram, 6 to 10 lbs. Bran, 1½ to 3 lbs. Salt, 1½ ounces.	Daily.

10. When once the organism of Surra has vanished for some days from the circulation of the animal under treatment, gentle exercise commencing with five hundred (500) yards, and gradually increasing to one mile, morning and evening, may be allowed. But if the temperature becomes elevated, all exercise must be stopped, until the former again registers within normal limits.

11. The exudation of semi-solid material (œdema) into the subcutaneous tissues, notably that of the lower extremities, sheath and under-surface of the abdomen, generally becomes absorbed after a time under the influence of Arsenic and exercise, but this may be accelerated by daily 'massage' of the body and limbs.

12. Surra horses, under treatment with Arsenic for long periods, and which eventually die, at their autopsies frequently present some atrophy of the spleen. Consequently subcutaneous injections of infusion of spleens have been made in order to ascertain whether the material injected would perform the function of the atrophied organ. Encouraging results have been obtained.

13. Certain of the Horse Surra cases under treatment somewhat suddenly developed symptoms of Chronic Arsenical poisoning. These, which include partial loss of power over the hind quarters, crossing of the hind limbs when walking, and general unsteadiness, and nervous tremours, usually proved fatal within 48 hours; although the further administration of the drug was immediately discontinued on their recognition. In some of the later cases under our treatment these fatal symptoms have been successfully combated by the subcutaneous injection of infusions of spleen and testicle (sheep).

14. The question with regard to the administration of Arsenic to animals at the commencement of the rains, as a preventive, in districts where Surra is epizootic, is one worthy of trial. A dose of five grains of Arsenic in the form of Liquor Arsenicalis (ten drachms) given once a day in the drinking water to each animal, could not fail to produce a beneficial effect, and could, with safety, be continued for a month at a time. The dose of Arsenic should then be gradually reduced every three days by half a grain at a time until it is discontinued altogether. An interval of seven days should then be allowed to elapse, and again the same process persevered in with intervals, until the termination of the rains, or end of October.

Remarks on Prevention and Legislation.

As it is recognised that Surra may be propagated in animals by means of drinking water, fodder, rat excrement mixed with corn, and the bite of certain kinds of flies, the following rules for guidance were drawn up some years ago (1894), and owners of dâk animals in certain Surra localities were informed of the best means of trying to protect their animals from acquiring the contagium.

The following are the most important:—

(i) All water for drinking purposes should be boiled, when possible, from June to October inclusive, before being given to the animals at stations in districts infected with Surra.

(ii) Hay should be made in cold weather (October to January), and stacked for the use of animals during the rains. The hay to be obtained from uplands, or from land not subjected to inundation, or better still from land entirely beyond the affected area. Green food should, during the rainy season, be prohibited, unless it is brought from without the Surra area.

(iii) All gram and corn to be screened and cleaned before being given as food.

(iv) The use of the bel (creeper) leaves as food to be discontinued during the months June and September (inclusive).

Suggestions applicable to animals working on certain dâk lines where Surra appears annually in the rains:

(i) Dâk animals, when returning to their own stage, should not be allowed to graze or drink water along the road, especially during the months of May to October inclusive.

(ii) A light preventive muzzle might be introduced.

(iii) All diseased animals should at once be isolated at a considerable distance from healthy ones, and subsequently destroyed if not subjected to treatment.

(iv) All carcasses should be burnt, together with the dung and stable litter, where wood is available for the purpose; otherwise, deep holes should be dug and the bodies buried at a depth of six feet.

* Boil half the daily quantity given to the animal morning and evening with half the amount of salt for 1½ hours, then mix with the bran and give when nearly cold.

(v) Stables should be erected on high ground, and not, as so frequently happens, in a hollow bordering on the bed of a river.

It is well known that Surra, when untreated, is an absolutely fatal malady; the disease taking an unusually rapid course in the case of overworked animals. When once the disease is diagnosed the animal is useless. Isolation and subsequent destruction, therefore, would entail no hardship to owners; and power to enable officers to enforce it, and the burning of all diseased carcasses would be a great step towards the limitation of outbreaks.

The question of the introduction of an Act to limit the spread of Surra, as in the case of Glanders, is an important one. It would be useless, however, to bring one class of animals (tonga ponies) under an Act, unless the other (ekka ponies) were likewise included; for, at present, the former only are under compulsory registration, although the latter are quite as numerous.

No Government official can interfere with animals the subjects of Surra; consequently, only advice can be given to the owners as to the best means of prevention against the spread of the disease.

II.—*Preliminary Treatment and Subsequent Inoculation.*

Observations were undertaken with the view to determine the efficacy of subjecting healthy animals to drugs, sufficient to cause the full physiological effects previous to submitting them to experimental inoculation with Surra.

(i). *By Arsenic in the form of Liquor Arsenicalis.*

No. XCVIII.—Australian mare, aged. After a period of observation lasting 22 days, during which daily observations were recorded of the water drunk, urine passed, and total urea excreted, the animal was submitted to a course of Arsenic in the form of Liquor Arsenicalis, with a view to determine the efficacy of subjecting an animal to the drug sufficient to cause the full physiological effects previous to submitting it to experimental inoculation with Surra.

The first dose was given on the evening of March 28th, 1894, and the administration of the chemical was continued until the morning of the 21st May 1894. Three hundred and twenty decimal point seven (320·7) grains in all were administered during a period of 54 days, or a daily mean of nearly six grains. At 5 P.M., on the latter date, the animal was inoculated over the left scapular region, with 0·7 c.c. of blood containing a large number of hæmatozoa, taken from a Guinea Pig immediately after death. The latent period occupied five days. As no protection was conferred by the Arsenic, which in this case averaged only 6 grains daily, instead of at least ten, owing to symptoms of gastric irritation supervening, a treatment of Iodide of Arsenic and Mercury was adopted, but this had to be abandoned for a like cause to the above. The animal succumbed on the 51st day of the disease, during which six paroxysms lasting 27 days and five intermissions lasting 24 days occurred.

In this case the latent period of the disease was not lengthened, but the organisms only attained to very numerous,—between 20 and 50 in a field of the microscope on four occasions during a period of 51 days the case lasted. Great difficulty was experienced in getting the animal to take the drug, so that although gastric symptoms appeared, the full physiologieal effect of the Arsenic was never produced.

No. CII.—Country-Bred gelding, aged. Arsenic administered from 27th June 1894. In all 430 grains were given. Died 9 P.M. 29th July 1894. The animal received an average of 13 grains for 33 days. Death took place from Arsenical poisoning, somewhat suddenly, just before the date for the inoculation test.

(ii) *By the Double Iodide of Arsenic and Mercury.*

No. XCIX.—Australian gelding, aged. After a period of observation lasting eight days, during which daily observations were recorded of the water drunk, urine passed, and total urea excreted, the animal was submitted to a course of medicine consisting of the Double Iodides of Arsenic and Mercury, with the same object in view as in the case of No. XCVIII animal. The first dose of v c.c. was administered on the evening of the 5th April 1894, and continued in increasing quantities until the morning of May 21st, a period of 46 days. In all 158 grains of each salt, Iodide of Arsenic and Iodide of Mercury, were given. At 5 P.M., on 21st May, the animal was subcutaneously inoculated with 0·8 c.c. of blood containing swarms of hæmatozoa taken from the heart of a Guinea Pig immediately after death. The period of incubation lasted five days, and the case lasted 59 days from the first appearance of the organism in the blood. There were seven paroxysms lasting 24 days, and seven intermissions lasting 35 days. As no protection against the Surra hæmatozoon had been conferred by the preliminary treatment of the Double Iodides, the animal was again submitted to the same salts; but, in addition, a small dose of Arsenic as Liquor Arsenicalis was administered at intervals. During the first five paroxysms, the fever assumed the typical relapsing form; for, within a few days, the temperature fell from over 41°C. to 37·4°C., equal to 7°F., and on a second occasion from 41·8°C. to 36·8°C., equal to 9·2°F.; but during the latter part of the case the temperature oscillated in the most irregular manner. Until six days before death, the organism never exceeded few (5 in a field), but frequently there was only one in a cover-glass specimen of blood.

The latent period of the disease was in no way altered by the administration of 150 grains of each of the Iodides of Mercury and Arsenic, but the course of the paroxysms was undoubtedly modified to a marked degree—only a few hæmatozoa being present at any one time in the blood examined—until a few days before death ; and, although the disease ran on for over eight weeks, the animal still maintained a fair condition. In this case the temperature assumed the typical relapsing type, which is rarely observed in inoculated cases.

No. CIII.—Country-Bred, aged. This animal was subjected to a course of the Double Iodides of Arsenic and Mercury, in gradually increasing doses, commencing with five cubic centimetres and terminating with twenty-seven cubic centimetres, twice daily, with a view to determining whether its administration would modify or destroy the Surra organism on subsequent inoculation. Between June 29th and July 28th, 1894, one thousand and seventy-four c.c. were administered. On 24th July this animal's temperature, 36·7°C., commenced to rise, and at 5 P.M. on the 26th had attained 40°C., and for the next two days remained high. On the morning of the 29th, the Surra hæmatozoon was found in its blood, and remained present until death on the morning of the 1st August. It was the intention to have continued the drugs for some time longer, previous to the subcutaneous injection of soiled blood being made, but as accidental inoculation took place by a fly or flies, it is supposed from a Surra horse standing some yards away, the experiment came to an end prematurely, showing that a mean of 35·8 c.c. of the Double Iodides, persisted in for thirty days, has no destructive effect upon the *Trypanosoma*.

Owing to the reasons given below, the drugs administered in cases XCVIII and XCIX were insufficient to withstand the unnatural test of subcutaneous inoculation.

It would appear that animals (horses) suffering from Surra have a greater tolerance of Arsenic than healthy animals, when the drug is administered for a lengthened period, as in the above experiments. Difficulty was experienced in getting the horses accustomed to be watered at a river or tank to take the drug (in water), or even pure water from a bucket. No such difficulty occurred in treating previously recorded Surra cases, received from the Tram-way Company and Mounted Police, Bombay, where the horses had always been used to the latter method. During an acute attack of disease only lasting a few days it is easy to administer drugs by drenching ; but in the treatment of Surra, when it is necessary to administer medicines to some twenty horses, two or three times daily, for a period of some weeks, with no establishment but coolies, drenching is out of the question. Any unnecessary disturbance of the animal and possible injury to the mouth is prejudicial, and would certainly retard recovery.

TABLE OF TREATMENT No. XXI.

Horse Number.	Treatment.	How administered.	Minimum dose.	Maximum dose.	Total quantity of each drug administered in.	Date from—to, under each form of treatment.	No. of days under form of treatment.	Date of disappearance of hæmatozoon from the blood.	Date of re-appearance of hæmatozoon in the blood.	No. of days hæmatozoa absent	Result of treatment.	No. of days which elapsed between first appearance of disease and death.	No. of days under treatment for Surra.
			Grs.	Grs.	Grs.								
CIV ..	Arsenic (Liquor Arsenicalis).	Gastric ingestion.	2·0	6·0	236·0	14th August 1894. to 17th September 1894.	35	18th August 1894.	....	31	Death.	42	35
CVII ..	Do. do. ..	Do. ..	4·0	6·0	52·0	25th September 1894. to 4th October 1894.	10	29th September 1894.	....	6	Do.	12	10
CVIII ..	Do. do. ..	Do. ..	2·5	7·0	379·0	27th September 1894. to 20th November 1894.	55	29th September 1894.	....	53	Do.	59	55
CIX ..	Do. do. .	Do. ..	2·0	7·0	561·0	5th November 1894. to 15th January 1895.	68	10th November 1894.	....	66	Do.	97	68
	Sulphate of Iron .	Do. ..	1 drachm)	drachm 1·0	47 drachms.	3rd December 1894. to 26th December 1894.	24	Do. ...					
CX ..	Arsenic (Liquor Arsenicalis .	Do. ..	1·0	grains. 7·0	321·0	5th November 1894. to 21st December 1894.	50	9th November 1894.	....	43	Do.	63	50
CXI ..	Do. do. ..	Do. ..	2·0	7·0	408·0	5th November 1894. to 26th December 1894.	52	10th November 1894.	8th December 1894.	18	Do.	69	52
CXII ..	Do. do. ..	Do. ..	4·0	7·0	539·5	9th November 1894. to 23rd January 1895.	76	12th November 1894.	....	73	Do.	79	76
CXIII ..	Do. do. ..	Do. .	2·5	6·0	135·5	29th November 1894. to 13th December 1894.	15	3rd December 1894.	....	11	Do.	35	15
CXIV ..	Do. do. .	Do. ..	1·5	6·0	92·5	29th November 1894. to 12th December 1894.	14	2nd December 1894.	....	11	Do.	21	14

Horse Number.	Treatment.	How administered.	Minimum dose.	Maximum dose.	Total quantity of each drug administered in	Date from—to, under each form of treatment.	No. of days under form of treatment.	Date of disappearance of hæmatozoon from the blood.	Date of re-appearance of hæmatozoon in the blood.	No. of days hæmatozoa absent	Result of treatment.	No. of days which elapsed between first appearance of disease and death.	No. of days under treatment for Surra.
			Grs.	Grs.	Grs.								
CXV ..	Arsenic (Liquor Arsenicalis).	Gastric ingestion.	2·0	6·0	455·0	29th November 1894. to 9th March 1895.	63		....		Cured	..	63
	Sodium Iodide ..	Do. ..	drachms. 2·0	drachms. 2·0	16 drachms.	30th January 1895. to 3rd February 1895.	5	4th December 1894.	....	..			
	Potass Nitrate ..	Do. .	2·0	2·0	14 ,,	12th February 1895. to 18th February 1895.	7		....	..			
CXVI ..	Arsenic (Liquor Arsenicalis).	Do. ..	grains. 5·0	grains. 6·0	115·5	1st December 1894. to 14th December 1894.	14	3rd December 1894.	....	12	Death .	26	14
CXVII ..	Do. do. ..	Do. ..	2·0	7·0	114·5	1st December 1894. to 17th December 1894.	17	2nd December 1894.	4th December 1894.	12	Do.	27	17
CXVIII ..	Do. do. ..	Do. ..	2·5	7·0	150·5	5th December 1894. to 31st December 1894.	26	6th December 1894.	....	25	Do.	43	26
CXIX ..	Do. do. ..	Do. ..	2·0	12·0	2239·0	6th December 1894. to 2nd July 1895.	209	7th December 1894.	*16th February 1895.	70	Do.	212	209
CXX ..	Do. do. ..	Do. ..	3·0	7·0	198·0	10th December 1894. to 14th January 1895.	36	12th December 1894.	....	34	Do.	43	36
CXXI ..	Do. do. ..	Do. ..	3·0	7·0	118·0	10th December 1894. to 24th December 1894.	15	11th December 1894.	....	14	Do.	29	15
CXXII ..	Do. do. ..	Do. ..	2·0	7·0	814·0	10th December 1894. to 24th April 1895.	135	14th December 1894.	4th February 1895.	52	Do.	148	135
									26th March 1895.	49			
									5th May 1895.	9			
									10th May 1895.	1			
									20th May 1895.	9			
CXXIII ..	Do. do. ..	Do. ..	2·0	7·0	580·0	23rd December 1894. to 15th March 1895.	83	25th December 1894.	13th February 1895.	50	Do.	100	83
									15th March 1895.	29			
CXXIV ..	Do. do. ..	Do. ..	1·0	7·0	389·5	23rd December 1894. to 9th February 1895.	48	26th December 1894.	....	45	Do.	64	48
CXXV ..	Do. do. ..	Do. ..	5·0	6·0	44·0	30th January 1895. to 4th February 1895.	6	31st January 1895.	....	5	Do.	30	6
LXXXIX.	Arsenic (Liquor Arsenicalis).	Do. ..	2·0	6·0	458·0	1st December 1893. to 3rd February 1894.	65	6th December 1893.	....	..	Cured .	..	171
	Double Iodide of Arsenic and Mercury.	Do. ..	c.c. 3·75	c.c. 15·0	c.c. 1822·0	4th February 1894. to 20th May 1894.	106						
XCVI ..	Arsenic (Liquor Arsenicalis).	Do. ..	grains. 4·0	grains. 6·0	grains. 178·0	26th October 1893. to 10th November 1893.	16	31st October 1893.	....	..	Death .	16	16
XCVIII .	Do. do. ..	Do. ..	1·0	4·	320·7	28th March 1894. to 21st May 1894.	55	Preliminary	Treatment.	..	Do.	51	87
	Double Iodide of Arsenic and Mercury.	De. ..	..	..	..	....	..	....	....	..	..	..	..
XCIX ..	Do. do. ..	Do. ..	c.c. 5·0	c.c. 15·0	c.c. 1000·5 { 158 grs. $As.I_3$ 158 ,, $Hg.I_2$	5th April 1894. to 21st May 1894.	47	Preliminary	Treatment.	..	Do.	59	107
CIII ..	Do. do. ..	Do. ..	c.c. 5·0	c.c. 27·0	c.c. 1074·0	29th June 1894. to 29th July 1894.	31	....	.. ..	..	Do.	..	..
XCI ..	Arsenic (Liquor Arsenicalis).	Do. ..	grain. 1·0	grains. 8·0	grains. 731·5	29th September 1894. to 7th January 1895.	101	4th October 1894.	30th October 1894.	16	Do.	..	..
									5th January 1895.	63			
									11th January 1895.	4			
	Double Iodide of Arsenic and Mercury.	Do. ..	v c.c.	vii c.c.	68·0 c.c.	8th January 1895. to 15th January 1895.	8	....	....	..	Do.	111	110
	Ferrous Sulphate ..	..	grains. 60	grains. 60	23·0 drachms.	4th January 1895. to 15th January 1895.	12	....	....	..	Do.	..	..

*2 subsequent paroxysms.

Section VII.

(A).—*Rainfall and Surra.*

The question as to what conditions influence the early or late advent of Surra in horses, is one of especial interest and importance, both from a practical and scientific standpoint. It is only in Government and private establishments, however, where careful records are collected concerning disease, that details can be obtained, from which deductions of any value can be drawn. In 1890, efforts were made in this Laboratory to compile statistics, with a view to determine what effect is produced on the appearance of the disease, by the varying amount of rainfall in different years. At present we have obtained statistics for the past ten years, with regard to the date on which the disease first made its appearance at the stables of the Bombay Tramway Company, together with the records of rainfall during the same period.

Table XXII.

Showing the monthly rainfall in Bombay for the years 1888—1897, with the dates of Surra outbreaks, and the number of horses attacked in each Surra season at the Bombay Tramway Company's Stables.

Months.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	Remarks.
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	
January	1·85	...	...	...	...	...	0·22	...	...	0·01	
February	0·02	...	...	...	...	0·14	...	0·07	...	...	
March	0·10	...	...	0·20	...	...	0·06	...	...	...	
April	...	...	0·01	...	...	0·02	0·01	...	...	...	
May...	...	0·67	0·06	...	0 11	6·30	...	0·08	9th 0·26	...	9th May 1896. One case of Surra *most unusual.*
June	15·76	19·89	24·55	13·99	13·30	21·47	16·87	17·84	28·02	14·40	
July	22·47	30·15	21·34	32·48	23·86	20th 16·14	26·16	18·04	36·44	30·19	20th July 1893. 3 horses attacked: 1 Australian, 1 Arab, 1 Persian.
August	11·43	10·32	10·61	6·94	36·56	13·57	11th 8·40	15·97	30th 20·77	13·82	30th August 1896. Regular outbreak commenced.
September	4·92	14th 2·71	6·45	13th 22·53	12th 18·73	7·52	12·04	2nd 11·91	1·62	20·60	
October	18th 0·11	3·80	6th 0·58	1·04	1·89	0·45	3·08	3·62	0·01	2·51	
November	1·16	...	1·25	...	0·67	1·63	...	0·06	0·53	26th ...	26th November 1897. Three Australians at Parel stables. Flies very troublesome.
December	...	...	0·13	...	...	0·22	0·01	...	...	...	
Total Rainfall for year.	57·82	67·84	64·98	77·18	95·12	67·46	66·85	67·59	87·65	81·53	Average annual rainfall for ten years. 73·40 inches.
Total Rainfall from 1st May to date of outbreak of Surra.	54·69	61·97	63·56	66·50	84·87	39·41	44·09	52·02	85·49	81·52	Average for ten years. 67·35 inches.
No. of horses attacked in each year.	14	47	2	1	15	11	10	17	19	3	Average death rate from Surra for ten years. 13·9.

As will be observed on reference to the above table, the most common months for Surra to appear (6 times out of ten) were September and October, twice it appeared in August, and once in July and November respectively; when a rainfall of 6·3 inches fell in Bombay in May 1893, three horses were attacked on the same day, *viz.* 20th July. It was then considered that the disease might be accounted for by the hæmatozoon or its resting form having escaped the great heat during the month of May, and so have retained its vitality, so that its power of re-producing the disease would be increased by the earlier rainfall and the outbreaks of Surra thus occur sooner. But in 1896 a sporadic case of Surra occurred amongst the same stud, consisting of some 700 horses on the 9th of May, a most unexpected occurrence, as up to that time only one animal (Australian, No. 65, owned by a private individual) had been observed with the disease, and that was contracted in the districts. From the first of the previous November until May 9th, 1896, only 0·06 of an inch of rain fell, and that was in the first mentioned month. Consequently here we have undoubted proof, confirmed by microscopic examinations of the blood of the animal, that Surra may appear in Bombay in the hottest part of the year, when no rain has fallen for six months. In ten years one animal out of 139 attacked with Surra developed the disease in the month of May, but the annual outbreak at these stables which carried away 17 horses did not occur until September, October, November of the same year towards the end of the monsoon season. On the other hand, it is a well established fact that in the great majority of years during which an excess of rain falls, the most severe outbreaks of Surra occur. In support of this statement the following outbreaks may be brought forward. During 1894 heavy rain fell on several successive days in September in the Ahmedabad, Baroda and neighbouring districts, thousands of equines succumbed to Surra during the October and November following, over an area of 400 square miles, and by order of Government the horse-fair at Ahmedabad was abandoned for a period of two years.

Note.—The large numbers in the rain columns denote the date on which the first case of Surra appeared.

Again on the Saharanpur-Mussoorie Dâk line 77 animals died of Surra, at stations in the Mohand Pass, during the rains of 1894, when the rainfall was in considerable excess of the normal.

In 1895, during the rains which were heavy, Surra caused its ravages in over 200 villages in the Karnal District, Punjáb. The losses among equines in sixteen villages in the above tahsil, where statistics were forthcoming, were 253 out of 556 kept or 45·50 per cent. During the same period 53 villages in the Saharanpur District, North-West Provinces, lost 909 out of a total of 1,590 or 57·10 per cent.

Let us now consider the outbreaks which occur annually at the foot of the outer Himalayas at Kathgodám in the Kumaon Bhabar. At my request meteorological observations were commenced at this station in 1896, and the following table shows the information we require, but for the past two years only :—

TABLE XXIII.

Stations.	Rainfall 1st June to 31st October in inches.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.
Naini Tal, elevation 6,350′ ..		123·02	81·85	63·73	126·91	105·19	85·10	63·85	114·93
Kathgodám, elevation 1,630′ .		...	...	...	...	...	...	50·71	108·52
Haldwani, elevation 1,200′ ..		100·06	65·91	56·38	83·73	92·96	69·16	63·82	91·86
Average number of horses		90	93	93	180	128	131	101	80
Horses died (of Surra) between the Brewery and Kathgodám ...		40	10	5	2	63	8	92	2

In 1896, 19·40 inches of rain fell during the month of *June*, and at the time that the monsoon ceased somewhat abruptly in August, 50·31 inches had fallen. Surra broke out amongst the Dâk animals in July, and 32 succumbed up to the end of August. When I visited the station on the 5th September, the blood of 24 ponies was found to contain the organism on microscopical examination, and in 9 animals it was found within the next few days, making 33 in all. Different varieties of flies make their appearance during the fine intervals of the monsoon, and in the year in question, when the rains terminated in August, flies invaded the Tonga Road in very large numbers, but no examples of the *glossina morsitans* were discovered. As the diseased animals were not destroyed or even isolated, we have not far to seek for the cause of the terrible mortality amongst the Tonga ponies. In the following year (1897) the rains only commenced on the 12th *July*, but continued until the month of October, a total of 108·52 inches falling. During the last mentioned season, however, immediately a Tonga animal was reported with fever, it was at once segregated, some miles away from the rest of the ponies, with the result that only two animals have succumbed to Surra during the season. It would also appear that the lateness of the setting in of the monsoon, together with the heavy downpour when it set in, and want of sun light and warmth also contributed, and brought about conditions unfavourable for the development of the *Trypanosoma* and flies in general.

With regard to Surra in other than Tonga ponies, it is no good the Railway Company going to great trouble and expense in order to provide boiled water, grass from an elevation of 6,000 feet, clean corn, prohibiting the use of green vegetation during the rainy season, and segregating all their sick animals, if small private owners of ekka, and riding ponies, etc., are allowed to keep their diseased animals in sheds or wandering about unattended within a few yards of the Company's stables or are allowed to ply for hire along the same narrow road. It stands to reason that the myriads of flies which abound and infest all animals at these seasons, have only to carry the *contagium* a distance of a few yards from the diseased to the healthy animals. In order to save expense and trouble the native owners on recognising that their *tats* are suffering from a fatal disease, turn them loose to shift for themselves ; consequently they become a source of danger to every healthy animal in the neighbourhood during life, and a disagreeable stimulus to the olfactory organs of passers-by for a varying period after death.

B.—The different ways by which Surra is acquired by animals.

Our knowledge up to the present leads us to suppose that animals (equines, bovines, solipeds and buffaloes) acquire Surra by the entrance of the *Trypanosoma* into their systems in one of four ways—

(i) From eating grass and vegetation grown upon land subject to inundation.

(ii) From drinking stagnant water, during certain months of the year.

(iii) From the bite of certain species of flies, probably as carriers of the virus.

(iv) From the ingestion of corn soiled with the excrement of the rat and bandicoot.

The general evidence collected on this subject will be summarised under their respective headings.

(i) The question of grass and water being the carriers of the contagium of Surra is so intimately associated, that it will be as well to consider these two factors together in their relation to the causation

of the disease. The distribution of this malady seems to be entirely influenced by the physical aspect of the country. It appears to be chiefly brought about by the occurrence of floods and inundations, being far more prevalent in those parts of the country where these occur than in the higher and drier portions. It is far more common in the vicinity of the rivers and canals than in portions of the country where water is scarce. It is not usual for the natives of India to make any provision for the maintenance of their animals in the form of hay or dried grass. The usual custom is either to graze their cattle where grass is to be found, or to cut it from the jungles and wastes as it is required. Towards the end of the hot season grass on the higher lands has become burnt up; at lower levels, especially at the bottoms of nálas, swamps, and ponds, where water has been lying till a much later period, an abundant supply can generally be found, and it is from these sources that it is procured.

Similar conditions operate at intervals during the wet season, or directly the rains have ceased, especially in those parts of this country where the temperature is high at this time of the year. The lands bordering on rivers and streams, or those which are low-lying, become flooded, the herbage is covered with water, which, in some cases, when the land has a clayey sub-soil, disappears almost entirely by gradual evaporation, and such places are favourable for the development of low forms of life, and possibly for the *Trypanosoma*. Animals, therefore, which daily consume grass and drink water from such localities run a risk of taking into their systems the *contagium* of this disease. In confirmation of these statements we may mention one example from many collected. The inhabitants of a village "Naoni" in the Ghaziabad Tahsil of the Meerut District, visited by Veterinary-Captain Pease in 1895, informed him that some forty out of sixty camels attacked had died out of a herd of 250. The people now drive the camels away to the Bangar or higher lying grounds during the rains, and water those animals which remain in the lowlands from wells only, in order to escape the disease. They attribute the disease to *stagnant water*, and do not allow their camels to drink at open places until the water has stood for a considerable time and become "pakka" (wholesome). On the other hand, Veterinary Captain G. H. Evans* reported the case of a pony which contracted Surra in a compound in Rangoon; the grass was obtained by its attendant from any source available, while the water supplied to the animal came from the municipal supply pipes. This was the first case of Surra acquired in that city observed by the above officer during a residence of some 6 or 7 years.

(III).—*The bite of certain species of Flies.*

It has been generally surmised from time immemorial that flies may be the carriers of the *contagium* of different diseases, but it was not until travellers in different parts of the world recorded individual instances that special attention was directed to these reports. In 1886, Livingstone brought forward evidence of the terrible losses to animals in Central Africa, the effects of the bite of the *Glossina morsitans*, and later Kay-Lees, in 1888, produced similar evidence of losses sustained to Government Transport animals in the Naga hills. But in both these instances microscopical proof was wanting. In 1891, Lingard demonstrated microscopically that the body fluids of certain flies, after sucking the blood of Surra animals, contained the *Trypanosoma* in varying numbers; and further that healthy animals inoculated with such soiled material, after a period of incubation, contracted the disease. In 1895, Bruce re-produced the Nagana disease in equines by taking them down to the fly-country and allowing them to be bitten by the '*Glossina morsitans*' but taking special care that the animals under experiment did not graze or drink water during the visit of some hours' duration to that locality.

From the above evidence, therefore, it is quite certain that some species of flies are capable of carrying the virus, and if their mouth and piercing organs are soiled with blood from infected animals, their bite may be the means of re-producing the disease in the animals bitten. The great point of interest, however, lies in the question whether flies can take in the '*Trypanosoma*,' when drinking water, &c., from the swamps and jungles, their natural habitat, and produce the disease by their bite in healthy animals, in the absence of a previous case of Surra. This problem remains to be settled, and until it can be proved that the organism in question has been demonstrated on the proboscis, or in body fluids of flies, in which no extraneous blood is present at the time of examination, the problem will remain unsolved. The question is a difficult one, and will take much time and careful investigation, but is one of special interest.

Limited outbreaks have been investigated in this country, where little or no evidence to help in the elucidation of the cause of the *outbreak* was forthcoming, and after exceedingly careful examination of the *pros* and *cons*, it, was impossible to form any conclusion as to why 6 out of 8 horses belonging to one European owner out of a total of 70, the others belonging to natives, should succumb to Surra, when all the animals were stabled within 200 yards of each other on the slope of a hill, 3,000 feet elevation, and when the animals attacked were the only ones which were subjected to proper attention and supervision. The solution of such a problem would necessitate that an observer should remain at the locality for some months and that careful microscopical observations of the body fluids of all species of flies caught on the animals be made daily from the end of the hot season until after the appearance of the disease, between July and November, for the onset of the epizootic varies year by year according to the rainfall of the locality.

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* Annual Report—Imperial Bacteriologist, 1896-97, page 20.

(IV).—*The ingestion of corn soiled with the excrement of the Rat and Bandicoot.*

In 1891, experimental inoculation of equines proved that out of twelve animals inoculated with soiled rat's blood, four or 33 per cent. contracted Surra and died of a virulent form of the disease in an average of seven days. The above experiments raised the question as to how rats could cause the disease in horses, for the food would rarely, if ever, be soiled with the blood of these small animals. It, therefore, only remained to be tried, whether the excreta of rats, in whose blood the infusorian was present at the time of its collection, could cause the disease when mixed with grain. Experiments with this end in view were carried out, and one Australian horse contracted Surra in 1893, the incubation period occupying some time between June and September during which the animal received daily rat excrement mixed with its ration of corn. This was evidence that when a horse is made to ingest soiled material day by day, Surra may finally be contracted; but whether the disease was ever actually produced in the natural course of events by this means at that time there was no testimony forthcoming. Enquiries were instituted in different parts of India in order to discover whether any folk-lore existed on the subject and syces and keepers of horses were interrogated for a similar purpose. In June 1895, one gentleman with many years' experience in India stated "that it was a fixed idea in the minds of many natives in the North-West Provinces and Oudh that if horses were allowed to eat corn soiled with rat excrement, some of them would be more than likely to die within a few months." Again the following statement was made by an old syce—"It is a common belief among syces that rat's dung in the corn given to horses makes them ill." Further testimony with regard to small animals was obtained to this effect. "Some years ago we lost a couple of goats, and the native who tended them said, death was due to the rat's dung we found among the stock of gram the animals had been fed upon."

From the above statement it will be gathered that animals can acquire the *Trypanosoma* or organism of Surra by different means, the thousands of equines which have succumbed to that disease in the Punjab alone have to shift for themselves, and under no circumstances obtain anything as fodder but the grass they can find, and water from the nearest source. Therefore, the question of rat excrement can be at once excluded as a factor in the causation of the disease in that class of animals. But with regard to the question of Surra being communicated by the bite of a fly, we know that when once the disease is started it may be re-produced to any extent by these insects. The evidence put forward with regard to the effect of rat excrement in corn is also of great importance to the horse-owner in India.

C.—Classification of certain species of flies caught upon the bodies of animals, in India and other countries.

All species of flies may become dangerous by transferring disease germs, which adhere to their mouths and limbs, from one animal to another, as when alighting and feeding upon the blood of a Surra patient they transfer their attentions to equines with some exposed wound or slight solution of continuity of the skin.

In such a case it is almost inevitable that the healthy animal will contract Surra. The species of the *Diptera*, which are essentially dangerous on account of their forminable bite, are provided with pointed instruments as sharp as needles, with which they pierce the cuticle and draw blood with the greatest ease. These species of flies are able to obtain for themselves, in the absence of sores on the bodies of the affected animals, the soiled material with which they may inoculate the healthy animals they bite. The flies which infest equines the most, during different seasons of the year in this country, appear to be as follows:—all through the year the *Hippoboscidæ*, two varieties (i) which principally attacks bovines and equines, (ii) a smaller variety which infests dogs. In the plains at the beginning of the rains, the Mhet (Burmese), a species of *Tabanus*, was always observed, also in Poona and the Mohand Pass (North-West Provinces).

In the hot season, especially towards the end of May and the beginning of June, before the rains set in, the large green-eyed fly the *Tabanus-lineola*, or an allied species, is present in great force. Sometimes it re-appears during a spell of fine weather, during the monsoon season, in September or beginning of October, but directly the cold weather sets in, these flies may be found dead by hundreds.

Several fairly large varieties of the *Muscidæ* have been caught on diseased animals, with their body cavities distended with blood, which, when submitted to microscopical examination, have been found to contain innumerable Surra hæmatozoa. These flies, up to the present, have not been identified and placed to their respective species.

At Poona the Surra animals, especially mules, and at the Surra Camp at Karnal, the horses were annoyed night and day by mosquitoes (*culicidæ*) which were only kept in abeyance by making fires to windward of the animals and allowing the smoke to envelope them.

In the plains of India the commonest variety is the 'louse fly,' which infest horses, cattle, sheep and other animals, especially dogs. They belong to the family *Hippoboscidæ*, "head prone; neck lying on the prosternum" which is again sub-divided into six genera, of which *Hippobosca*, the first, is frequently separated as a sub-order under the term *Pupipara* on account of the curious method of re-production.

The following notes, with regard to the above mentioned families of *Diptera*, have been abstracted principally from the works of the chief British and American authorities on this branch of the science.

Walker includes *Hippoboscidæ* under the *Eproboscidæ*. Loew and Sacken objected to uniting under the head of *Brachycera* all those families which cannot be referred to the Nemocera, especially to the union of the *Hipposcidæ* with the other *Brachycera*, since both the history of their development and their internal and external anatomy essentially differ from them. These authorities include them under a third section, *Coriacea*, co-ordinate to the *Nemocera* and *Brachycera*, and having the same systematic value.

"The species of this family pass their egg-like and larva state in the body of the mother, and when born are pupæ or larvæ just ready to assume the pupa state, as is proved by their size, which nearly equals that of the parent fly, by their slight motion when first extruded, by spiraculiform points which run down each side of them, and by their changing into perfect flies. Each female produces a single egg. The proboscis consists of a pair of hairy coriaceous valves, which include a very slender rigid tube or siphuncle, the instrument of suction, which is formed by the union of two setiform pieces."—(F. Walker).

According to Dufour and Leuckart, quoted by Packard, the females of this species have all irregular uterus-like enlargement of the oviduct, which furnishes a milk-like secretion for the nourishment of the larvæ.

"The flies are parasites living largely upon birds, but sometimes upon animals. The whole body is depressed or flattened, and birds of prey are most usually affected. It is rare to find a hawk, eagle or owl upon which several specimens of these peculiar flies cannot be found. They move rapidly, and their first impulse is always to seek shelter when driven from their original host. A few species are wingless, and among them is the so-called 'sheep tick,' *Melophagus ovinus* which is usually looked upon as a louse, and resembles one in the prominent proboscis, the lack of wings and the strongly developed legs, on which the claws are very prominent."—(Smith).

The Forest-fly or Horse-tick (*Hippobosa equina*), is very abundant in the New-Forest, Hampshire The description given of it by Walker is as follows :—"*Nigra, capite thoraceque fulvo flavoque variis alis sordide hyalinis, pedibus fulvis, tibiis posterioribus et femoribus nigro-subfasciatis, unguibus nigris.* Long. 3-3½; alar 8 lin." According to A. E. Omerod, the forest-fly may be taken as a type of the division. It causes irritation both by blood-sucking, and by creeping, which it can do backwards, forwards or side-ways, with great nimbleness, on the parts of the animal especially preferred for infestation.

Another set of troublesome creatures in India are the Gad-flies or Horse-flies, belonging to the family *Tabanidæ*. This order, I think, includes the 'Bara Dhang' (Hindustani) and Hmet (Burmese), which are probably varieties of the species *T. lineola* the green-head fly and *T. tropicus*.

"They have short, broad heads, enormous eyes, and short, though many jointed, feelers. The abdomen is oval, a little flattened, and the body is convex and powerful. The mouth parts are well developed, consisting of a series of five sharp-pointed lancets, so rigid that they readily pierce the skin and draw blood almost as soon as they touch. These flies appear in the Summer, chiefly abound in woods, or the edges of woodland, and sometimes in low meadows or marshy places. The flight is powerful; the males frequent flowers, the females with their sharp mouths, pierce the skins and feed on the blood of quadrupeds. In England the ox-gad-fly, *T. bovinus*, is the most common variety; but in the United States *T. Atratus* is a common species, while the *T. Cinctus*, orange-belted horse-fly, is smaller and less abundant. The *T. lineola*, as in India, is the most common American species,—thousands of them appearing in the hotter parts of the Summer, when the sun is shining on the marshes and western prairies; horses and cattle are sometimes worried to death by their harassing bites. In cloudy weather they do not fly and they perish on the cool frosty nights of September."—(Packard).

Mr. Walsh has shown that in its larval state the horse-fly is useful to man, as it feeds on snails and probably the larvæ of other root-eating insects. The larvæ of other species are aquatic, living under submerged objects.

The family *Muscidæ* is the largest in number of genera and species in the order as well as the most difficult to classify. The common 'House-fly,' 'the Blue bottle' and the 'Flesh fly' are examples and may be considered as typical forms which most of the species resemble, not necessarily in colour or markings but in general type of structure.

The *Blow-fly.—Calliphora Vomitoria.*

The "Screw-worm-fly"—*Lucilia macellaria*, a common species, usually feeds upon dead or decaying animal matter. Under some circumstances, however, it attacks living animals, and occasionally becomes a pest in the South or South-west States of America.

The Stable-fly.—*Stomoxys Calcitrans.* This has the mouth parts formed for piercing, and annoys animals by alighting upon and sucking the blood of parts that cannot be reached by them with head or tail.

The Horn-fly.—*Hæmatobia serrata.* Like the stable-fly is a blood-sucker, and both species are often found on animals at the same time.

Francis Walker—Insecta Britannica 'Diptera'— 1853, London.
A. E. Packard—Study of Insects—1869, United States, America.
J. B. Smith—Economic Entomology—1896, United States, America.
A. E. Omerod—Agricultural Entomology—1884, London.
H. Loew and Osten Sacken—Monographs of the Diptera of North America—1862 to 1873, Smithsonian Institution, Washington.
Smithsonian Institution—Bulletin of the United States, National Museum—1886, Washington.

The Tse-tse-fly, *Glossina morsitans*, is a member of this family. It is allied to *Stomoxys*, the species of which bite very sharply.

In 1885 *Railliet* gave the following resumé of the history of this insect :—

"The fly to which the Negroes give the name of *Tse-tse* is met with throughout nearly the whole of Central Africa. It appears to prefer hanging about the borders of marshes and watering-places and in beds of reeds. It makes a loud buzzing noise, which is easily recognised again when it has once been heard. If Bruce is to be believed, the buzzing of the *Tse-tse* is a mixture of dull and sharp sound, which is somewhat discordant. This buzzing causes more terror and disorder among men and animals than the monster of the countries they inhabit could produce, if they were twice as numerous."

'Many travellers, among them Livingstone and Oswald, have stated that this fly is one of the most redoubtable scourges of the African torrid zone; nevertheless, the descriptions published with regard to it have, it appears to us, something of a legendary character. Like the *Stomoxes*, the *Tse-tse* attacks man and animals. It darts on the latter, say the travellers, with the rapidity of an arrow, and prefers biting them inside the thighs or beneath the belly, and a tumour soon forms at the part attacked.

'It has been said that this insect prefers the uncovered parts of the body; the action of its bite on man is no more dangerous than that of the gnat; that the domesticated animals, on the contrary, with the exception of the ass, the elephant and the goat, begin to waste away immediately, and soon succumb; that dogs resist the bites when they are fed on venison, but perish when they receive milk; that calves nourished on milk, on the contrary, are exempt from injury, &c. On autopsy, the heart, lung, and liver are found more or less affected.

'The majority of these descriptions of the older travellers have been contradicted by more recent observations. Thus a Belgian expedition has lost several elephants; *P. Baur* has witnessed several of his asses perish as a result of the stings of this fly, and he asserts that, instead of preferring uncovered parts, the *Tse-tse* usually gets underneath the clothing and up the sleeves of men, and below the tail of animals. Others have observed that those bitten generally succumb as a consequence of the gradually increasing weakness, which may continue for several weeks, and even months. Finally, the most careful autopsies have not revealed any lesion of the spleen, liver, lungs or brain.'

"All these contradictory statements show that the action of the *Tse-tse* punctures is extremely variable, and that, consequently they ought not to be venomous. Besides, Nocard and myself have introduced, without any result, beneath the skin of the thigh of a sheep, the head and proboscis of a *Tse-tse* brought from Zanzibar a short time before by Paul Lervy."

"In reality the *Tse-tse* can merely be regarded as a carrier of virus, and its bite is only dangerous when its proboscis has been previously infected. With regard to the virus which it habitually inoculates, it is difficult, in the present state of our knowledge, to say what it actually is; but contrary to what Mégnin has advanced, it is impossible to say it is that of anthrax, at least in the majority of instances. We have already given the opinion that it might well be the virus of various maladies, and perhaps even of affections peculiar to Central Africa. This manner of looking at it appears the only way by which to explain the diversity of statements given by travellers."

S. Caltricans has a well developed proboscis, enabling it to bite severely.

The *Warega-fly* of Brazil, which is said to be a "pest of both man and animals", is a species of Musca and is said to lay its eggs in the skin; large and painful swellings are formed.

The "*Idia Bigoti*", according to Coquerel and Mondiere, produces a disease in the natives of Senegal, probably by ovipositing on the skin, thus giving rise to hard red fluctuating tumours in which larva of this fly reside.

The family of Mosquitoes or Gnats (*Culicidæ*) have the mouth parts very long and slender; the maxillæ and mandibles are free and lancet-like. The females alone bite, for in the males the piercing mouth structures are not well developed, and they are therefore not capable of sucking blood, but spend their lives in the retirement of the swamps and jungle.

"This genus is too well known from the blood-sucking propensity of the female, to require any particular notice. It is plentiful in all countries, whether arctic or tropical, which abound in wood and water. The female lays about 300 eggs; nearly a month intervenes between the egg-state and the fly-state, and there are several successive generations in one year. Gnats emit no sound when flying early, before their thirst for blood is awakened. The warmer the weather, the greater is their thirst for blood, the more forcible their flight, the motion of their wings more rapid, and the sound produced by that motion more intense."—(Walker).

Ixodes, popularly known as ticks and wood-mites, are more or less flat when fasting, globular when replete. The Ixodes are found in every country, but there is no constant correspondence between the species of host and that of the parasite; the specific determination of the different forms is rendered difficult by the great confusion that prevails. The male and female of the same species have often been mistaken for different species and the same species has received distinct specific names, because individuals belonging to it were observed on different hosts. Animals, however, as a general rule, do not appear to suffer from their presence. "In Guadeloupe, the Ixodes of Senegal are supposed to play an important part in the development of a serious affection known there as *farcy*, and which is witnessed in horses, cattle and mules; the ulcerous wound just referred to is the starting point of the disease. Nocard has recently demonstrated that this 'farcy of the ox' is a malady of microbic origin; and it can be conceived that the Ixodes may be the agents of inoculation of micro-organism that determines such a disease."—(Neumann).

The presence of the *trypanosoma* of Surra in the body fluids of certain species of flies* caught near to or on the bodies of animals (horses, dogs) suffering from that disease, were frequently observed

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Railliet—Art: Mouches, Nov. Dict. Prat. de Méd Chir. et Hygiene Veterinaires, Vol XIII. Paris, 1885.

* Nawabkhan, the Camel Jamadar of the 3rd Punjáb Infantry, has the reputation of knowing more about the camel than any body else in the district, and he communicated to me the following information as interpreted by Major Money, 4th Punjáb Cavalry :—

"The prevailing opinion among the natives in this district is that *Surra* is caused by the bite of a large brown fly (the size of a small bee) called *Bhura dhang*. In the month of May that fly comes from the ground in jungle-land that has been under water. In June and July the flies are very numerous and in full force; about the 15th August they begin to diminish, and

and demonstrated at the Poona Laboratory in 1890. We have before pointed to the fact that when once the disease exists, its further development in other animals is frequently due to the bite of flies, which carry the soiled blood on their piercing organs.

The chief question which presented itself for solution was whether the *trypanosoma* is ever to be found in the body fluids of flies and ticks, (i) during the hot season of the year, when it is very exceptional to find a case of the disease, (ii) during the early part of the rains before the disease has manifested itself in animals. In order to elucidate the above problems it was necessary to visit the localities known to be Surra centres, during the hot season, but just before the rains usually commence at the end of May and beginning of June ; and a second time about the end of August and beginning of September, the middle of the rains, on each occasion to systematically make a very large number of microscopical observations of the different fluids to be examined. With this object in view (i) in the hot season, numerous specimens of the thoracic and abdominal fluids of the following species of *Diptera* were submitted to microscopical examination.

(*a*) Large green-headed fly.—*Tabanus lineola.*

(*b*) Large brown-headed fly.—*Tabanus tropicus*

(*c*) Horse and cattle fly.—*Hippobosca maculata.*

(*d*) Small variety infesting dogs.—*Hippobosca.*

(*e*) Local varieties of the—*Muscidæ.*

(*f*) Mosquitoes—*Culicidæ.*

Flies obtained from every available source were submitted to microscopical examination. During a sojourn in a Surra locality we engaged coolies to supplement our own staff, consequently fresh supplies of *Diptera* were brought in several times daily. These were carefully examined in the fresh state. In different districts one or more species of flies were generally found to predominate, but they varied also in number and species according to the season of the year.

The microscopical examination of the water, mud, fresh water shell-fish, flies and ixodes collected during the hot season observations, failed to reveal the presence of any form of *Trypanosoma.*

(ii) During the rainy-season tour, hundreds of flies belonging to some ten different species, together with ticks from equines and canines, were collected and their body fluids submitted to microscopical examination, but in all cases with negative results as regards the presence of the *Trypanosoma.*

Veterinary-Captain G. H. Evans, during his tours in Burmah, has been good enough to make a large number of microscopical observations for this report, but has failed to detect anything like the Surra hæmatozoon in the jungle *diptera* examined. He states that a fly exists in Burmah, a little larger than the common house-fly, with body yellowish in colour and with its legs bent on themselves. At the point where this fly bites, a small extravasation of blood appears just under the skin, which shortly after presents the appearance of a blood-bleb, such as follows a contused wound. These insect pests are present in great numbers just before thunder-storms at the termination of the hot season, not only in the plains, but also at Thandaung in the Karen and Binjyi in the Shan Hills. The *Gaur* (Indian Bison) and *Tsaing* suffer from rinderpest, and foot-and-mouth disease, yet these animals have, up to the present, never been observed with Surra, although careful search for the disease has been made. They live in heavy jungle, where the flies are so annoying to them that they have to go in the open to escape their attacks.

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early in October they are obtained with difficulty. The fly bites horned cattle and donkeys, but they suffer no ill effects; it bites men, and a painful swelling follows; it bites horses and camels, and gives them a fatal disease known by several names, such as *Khanhog, doaia* and *Surra*, depending upon the several stages. *Phipri* is another name by which it is known among camels. I know of no reason for saying that the fly causes the disease except the common tradition of my people."—G. Evans' Report on 'Surra' 1880, Loc : cit.

"The author had the opportunity of seeing the fly (*Glossina morsitans*) several times in the jungle a few marches from Nichugard, and when he found that nearly all the ponies and mules had died of debility or a gradual wasting away of the body, he naturally associated the fly with the disease. The symptoms noted in equines were a gradual but persistent wasting of the animals affected : in fact they became so emaciated that one might be readily led to suppose that they were dying of starvation. No cases, as far as I could learn after the fullest inquiry, had ever been known to recover. Comparing the above symptoms with those described in Dr. Livingstone's work, and having personally seen the insect, I have not the slightest hesitation in attributing the mortality amongst the transport animals on the Naga Hills to the Tse-tse fly."—Kay-Lees, 1888, Loc : cit.

In the forest region of Korea insect pests abound in the summer months. Mosquitoes, gnats, and gad-flies make the lives of the settlers perfectly burdensome for two or three months of the year, and *ponies* and *bulls* quickly succumb to their attacks. The houses are kept constantly filled with birch smoke to drive them off; cattle are protected by fires of green wood in the open, and men working the clearings carry coils of rope made from dried *artemesia*, which burns slowly and emits a pungent odour, for the same purpose—C. W. Campbell, 1892, Loc : cit.

SURRA IN BOVINES AND BUFFALOES.

Surra as it affects bovines and buffaloes will be treated of under the following headings :—

(i). Bovine Surra acquired spontaneously.
(ii) Bovine Surra following inoculation.
(iii) Buffalo Surra following inoculation.

Section I.

Spontaneous Cases in Bovines.

(*a*). Historical Account of Spontaneous Disease.

The first reference to the subject of the likelihood of bovines acquiring Surra is to be found in Evans'* Report in 1880, where the following quotation is taken from :—

" I took every opportunity of asking the Zamindárs at the outposts whether they knew of the disease amongst horned cattle and donkeys, and they all assured me in the negative. Colonel McLean, 1st Punjáb Cavalry, however, was told by one Zamindár that ' cattle do suffer from it, and they get it in consequence of eating *dheela* grass which grows upon inundated land, some part of which, either the root or some other part, contains a worm or an insect of some kind in June or July. The cattle eat it, then it gives them the seeds of the disease which does not break out before the cold season.' "

The next reference is one by *C. W. Campbell*†, which we think can only have been ' Surra,' for, if the inoculated disease had been Anthrax, human beings would also have succumbed to the bite of the flies, and if rinderpest, the ponies mentioned would not have contracted the malady. The quotation is as follows :—" In the forest regions of Korea, insect pests abound in the summer months. Mosquitoes, gnats, and gad-flies make the lives of settlers perfectly burdensome for two or three months of the year, and ponies and bulls quickly succumb to their attacks. The houses are kept constantly filled with birch-smoke to drive them off ; cattle are protected by fires of green wood in the open ; and men working the clearings carry coils of rope made from dried *artemesia*, which burns slowly and emits a pungent odour, for the same purpose."

In 1895, Lingard‡ reported on an outbreak of Surra in equines, and in his report states—" on the 14th December in company with Veterinary-Lieutenant F. Eassie, I visited the Bullock-Hospital, and picked out two bullocks, Nos. 13 and 152, as being likely subjects of Surra. On the morning of the 15th instant specimens of blood from both these animals were submitted to microscopical examination, and the Surra hæmatozoon was found to be present in both. Bullock No. 13 succumbed at 2-45 P.M. on the 16th December, and the usual pathological conditions of the organs were noted. On the following morning I demonstrated to Captain Birdwood (Superintendent, Karnal Government Depôt) the presence of the ' Embryo Filaria,' in addition to the Surra hæmatozoon, in a specimen of blood taken from the surviving bullock No. 152. Since that date this animal has passed through a paroxysm of high fever, due to the organisms of the two diseases (Surra and Filariasis) being present concurrently. At a later date I again visited the Bullock-Hospital in which were twenty-three patients. The blood of twelve of the animals was selected and subjected to microscopical examination, but in no instance was the Surra organism detected."

In 1896, M. A. Legrain§ discovered a hæmatozoon belonging to the class of flagellate infusoria, genus *Trypanosoma*, in the varicose dilitations developed on the external surface of the pericardium of a cow, killed at the Abattoir at Bougie, France. This infusorian has not been brought to notice before, in bovines in France.

The author remarks that the *Trypanosoma* does not sensibly differ from the parasites met with in fish, frogs, birds, rats, camels and horses, found in the last mentioned in India, Syria and in Egypt. The parasite in question is an organism formed of protoplasm furnished with a flagellum, a nucleus, and an undulating membrane and measures about 50 μ. The carcass of the cow did not present any organic lesions, but emaciation and an anæmic condition were marked. The varicose dilitations resembling bunches of grapes alone attracted attention, but these can scarcely be attributed to the presence of the organism.

Livingstone‖ in his work on the Zambesi states that the bite of the *Glossina morsitans* is death to the ox, horse and dog. In one journey " though we watched the animals carefully, and believe that not a score (flies) were ever upon them, they destroyed forty-three fine oxen." Livingstone observed that " a

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* Report on ' Surra ' disease, by G. Evans, M.D., A. V. D., dated 13th November 1880—No. 27 B.

† *C. W. Campbell*—A Journey through North Korea to the Chang-pia Shan. *Journal, Royal Geographical Society*, March 1892, p. 155.

‡ Report on outbreak of Surra and Filariasis at Karnal, Government Depôt, 1895.

§ ' Trypanosome des Bovides' Re Le Progres Veterinaire, No. 11. 15 Mars 1896. Also Recueil Veterinaire VIII Série, Tome III, No. 7.

‖ *Livingstone*.—Opera cit.

most remarkable feature is the perfect harmlessness of the bite in man and wild animals, and even calves, so long as they continue to suck the cows, though it is no protection to the dog to feed on milk..... In the ox the immediate effects are no greater than in man; but, a few days after, the eyes and nose begin to run, the coat stares, a swelling appears under the jaw and sometimes at the navel, and though the poor creature continues to live and graze, emaciation commences, accompanied by a peculiar flaccidity of the muscles. This proceeds unchecked until perhaps, afterwards, purging comes on, and the patient dies in a state of exhaustion."

To show the great ravages caused by this disease the author mentions that "Lehlunane once lost nearly the entire cattle of his tribe, amounting to many thousands, by intruding unwillingly upon the haunts of this murderous insect."

Bruce states that with regard to the Tse-tse fly disease or Nagana in Zululand, that it is invariably fatal in the horse, donkey and dog, but a small percentage of cattle recover. The African disease is characterised by the *constant* occurrence in the blood of an infusorial parasite, either identical with or closely resembling the *Trypanosoma evansi.*

(*b*).—Pre'cis of Cases.

In two cases of spontaneous Surra in bovines (Hissar bullocks), observed at Karnal during the months of December 1895 and January 1896, the animals had been ailing for some four months, but thin and emaciated only during the eight weeks prior to my visit. In both these cases the attack of Surra was complicated by the presence of large numbers of embryo *Filariæ* in the blood, in addition to varying numbers of the '*Trypanosoma evansi.*' For three days previous to the death of No. 13, the temperature ranged between 95° and 105° F,, a variation of ten degrees, but at the autopsy few pathological changes were noted, and those of a slight character. No. 152 Bullock, which presented quite as an advanced condition of Surra as the one that succumbed, very gradually recovered, at a later date, September 1896, had put on flesh, and presented a good condition, although for some time it was quite off its feed, and only ate when tempted by lucerne grass being placed in its mouth. The temperature in this case ranged between 99° and 107°F., and for a considerable period, after the special Surra symptoms had passed, the morning remissions and evening exacerbations of temperature were most marked. This fever of an intermittent type was not due to Surra or Filariasis only, alone or combined, but was a special form of disease of malarial origin. For at Karnal malarial fever in bovines and equines appears alone, as well as complicating other disorders.

Section II.

Bovine Surra following Inoculation.

The course which Surra takes in bovines, when acquired either spontaneously or after inoculation, has been very briefly pointed out in my earlier reports on this disease. It will be as well, however, to recapitulate the leading facts known concerning these animals, in order to compare them with the symptoms and course of Surra in buffaloes, now recorded for the first time.

Some five or six bovines were subjected at Poona to inoculation with the *Trypanosoma* from different animals, *viz.*, horse, rat, and the latter organism after it had been passed through equines. All these animals survived the first attack of the disease, and subsequently were respectively exposed to re-inoculation with material obtained from a more virulent source to that injected on the first occasion. In no instance did any serious symptoms follow as a consequence, but at a later period Bull No. III and the calf contracted rinderpest spontaneously, and succumbed to it, 232 and 234 days respectively, after the date of their re-inoculation with Surra.

In the following précis will be found the chief facts noted in the case of each animal, together with a tabular statement giving the fullest details.

Pre'cis of Cases.

Bull No. I.—Deccani-bred. This animal was kept under observation for some time, during which it appeared quite healthy. It was subcutaneously inoculated on 24th March 1891 with 1·75 c.c. of blood, containing numerous Surra hæmatozoa taken from the jugular vein of Horse No. XIX. A considerable amount of swelling and œdema, with tenderness on manipulation, followed at the seat of inoculation. On the evening of the 28th May the temperature rose to 39·7° C., and on the following morning one hæmatozoon was discovered on microscopical examination after searching through several specimens of blood. On the 30th no hæmatozoa were found in the blood, but on the 31st and 1st April a few were observed; from this date until the 17th June no more hæmatozoa or their immature forms were seen, although carefully searched for. On June 17th, eighty-five days after the inoculation of the animal, two Guinea Pigs were inoculated subcutaneously with 0·2 c.c. of blood from the bull. No. I Guinea Pig developed hæmatozoa in the blood on the 27th, ten days after inoculation, whilst No. II Guinea Pig did not develop any until the 5th July, or eighteen days after inoculation. The organisms were present off and on in the blood of these animals for a considerable period, No. I finally succumbing to the disease on the 8th of November 1891, or 144 days after its inoculation, whilst No. II died on the 12th October 1891 or 117 days after inoculation. During the interval which elapsed between the 17th June and 3rd September 1891, no hæmatozoa were discovered in the blood of the bull, although

several cover-glass specimens of it were examined every day. Consequently two more Guinea Pigs were inoculated. These were distinguished as No. III and No. IV and each received 0·2 c.c. of blood from the bull on the 163rd day after its inoculation. Nos. III and IV Guinea Pigs both developed hæmatozoa on the 10th day, and the organisms remained almost constantly present in their blood until the day of the death, 24th October and 14th December respectively.

On the 13th November 1891, that is, 234 days after the inoculation of the bull, two Guinea Pigs Nos. V and VI were inoculated with 0·2 c.c. of blood from that animal, but as no hæmatozoa were found during the next 32 days, they were re-inoculated on the 16th December 1891, 267 days after the inoculation of the bull, but with negative results a second time. Between the latter date, 16th December 1891 and March 14th, 1892, the bull appeared to be enjoying good health and putting on flesh. On this latter date, that is, 356 days from the time of inoculation, two new Guinea Pigs Nos. VII and VIII were inoculated as previously with 0·2 c.c. of blood from the bull, but this experiment was also followed by negative results. Since 24th March the bull has been in very fine condition, and as it is desirable to ascertain whether animals of the bovine species are liable to a second attack of Surra, it was resolved to re-inoculate this animal with a more virulent type of Surra, obtained by passing the hæmatozoon of the rat (*Mus decumanus*) through the horse and donkey. This second inoculation was performed on 22nd August 1892, when 1·0 c.c. of blood drawn from the jugular vein of the donkey was subcutaneously injected over the left scapular region, the blood at the time containing very numerous and active hæmatozoa. No swelling and œdema followed, only slight subcutaneous thickening in the tract of the injection needle. On the 28th of the same month, a peculiar organism was found in the blood, but on that day only. The animal put on flesh and appeared in robust health. On 21st September 1892 two Guinea pigs were inoculated with blood drawn from the jugular vein, but up to the 14th November 1892 their blood, which had been examined daily, failed to show any signs of the Surra hæmatozoon.*

The blood of Bull No. I was submitted to microscopical examination until the 22nd July 1893, a period of 345 days after the date of the second inoculation. No Surra hæmatozoa were observed, but only one giant form of *Trypanosoma* on 27th August 1892.

The chief points of interest amongst others in this case are that—

1. This is the first recorded case of any of the bovine species having been successfully inoculated with the hæmatozoon of Surra.
2. The animal should have entirely thrown off the disease, and again become strong and in good condition, is worthy of notice and may prove important in the future treatment of the disease especially when we recall the absolute fatality observed amongst horses afflicted with this malady.
3. After re-inoculation with a more virulent form of material, primarily derived from the rat (*Mus decumanus*), no local manifestations should occur at the seat of the injection of blood, or symptoms of the disease follow.
4. The loss of virulence on introduction of the hæmatozoon into the bovine species points to the fact that there may be a possibility of producing some form of immunity in other species of animals by the introduction subcutaneously or by intravenous injection of the blood, serum, or proteid matter from the blood of bovines, some time after their inoculation or re-inoculation on numerous occasions with Surra.

Bull No. III, aged 4 years. This animal was subcutaneously inoculated on the 31st July 1891 with 1·0 c.c. of blood containing very numerous hæmatozoa taken from the jugular vein of Horse No. LXVII, previously passed through the horse from the rat (*Mus decumanus*). A considerable amount of swelling and œdema with tenderness on manipulation followed at the seat of the injection. The latent period occupied three days. The hæmatozoon was present in the blood from the 3rd to the 9th August inclusive. After an interval of thirteen days it was again present in small numbers for two days, August 23rd and 24th, after a second interval of nine days it re-appeared for one day on the 3rd September. During a further period of 158 days accompanied by daily microscopical examinations of the blood, no organisms were observed. The temperature became rapidly elevated after inoculation and attained a maximum of 41·4° C. on the 4th day of the disease, and then gradually fell until the morning of the eighth day when it registered 38·8° C. It again rose to 41° C. on the 37th day. The pyrexia since November 14th has been characterized by morning remissions and evening exacerbations especially on the 143rd, 155th, 156th, 168th and 178th days of the disease. During the months of August and September this animal became greatly emaciated, but by December had put in a considerable amount of flesh and appeared quite healthy.

On the 3rd September 1892, the 191st day after inoculation and the 158th since the last appearance of the organism in the blood, it was decided to re-inoculate the animal with Horse Surra blood in order to test whether any protection had been acquired from the previous inoculation. Consequently on February 9th, 1893, the animal was re-inoculated subcutaneously with 2·0 c.c. of blood drawn from the jugular vein of Horse No. LXXXIV immediately after death, but which just before death contained numerous hæmatozoa.

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* Two Guinea-pigs inoculated on the 21st September 1892 with 0·3 c.c. of blood in which no hæmatozoa could be discovered microscopically, contracted Surra after a latent period of 14 days.

No swelling or œdema followed, but there was only a slight thickening of the tissues on the 4th day at the seat of the injected blood. Three paroxysms occurred, viz., on the 1st, 111th and 233rd days lasting 1, 2 and 3 days, with two intermissions occupying 109 and 120 days respectively.

The animal contracted rinderpest on the 26th September 1893, although isolated with several other bovines in an enclosed area, surrounded by a wall 7 feet in height, and succumbed on the 28th September.

Bull No. IV, was inoculated on July 27th, 1892, with 2·0 c.c. of blood containing the hæmatozoon, taken from the rat (*Mus decumanus*) immediately after death. A considerable amount of swelling and œdema followed at the seat of the injection which gradually decreased in extent and finally disappeared about the 10th August 1892. From the 27th July until October 10th, 1892, the blood remained free from the hæmatozoon, on the evening of the 9th September an urticarial eruption broke out on both sides of the neck, chest and scapular regions, but had disappeared entirely by the following morning. On the morning of the 3rd October a similar eruption to the former made its appearance and again faded the same day. On microscopical examination of the blood on the 11th October, the 76th day after inoculation, a long and active *Trypanosoma* was discovered, the dorsal membrane being particularly well developed. From the latter date up to the 9th February 1893, the 21st day of the disease, no further hæmatozoa were observed, although several specimens of the blood were subjected to careful microscopical examination daily. The temperature on the morning of the 8th day following inoculation attained a maximum of 41° C., but by the following morning had fallen 2° C., and although it subsequently on numerous occasions reached 40° C., it has only risen to 40·3° C. Since November 16th the pyrexia was characterized by marked morning remissions and evening exacerbations, especially on the 55th, 56th and 59th day of the disease, when the morning and evening temperatures varied from 2·5° C. to 3° C. (4·5 to 5·4° F.). The animal lost flesh during the months of August, September, October and November, but in January 1893 began to put on flesh.

On February 9th, 1893, 197 days after the inoculation with rat's blood and 121 days after the first and last appearance of the hæmatozoon in the blood, it was decided to inoculate the animal with Horse Surra blood in order to test whether any protection had been acquired from the previous inoculation. Consequently, the animal was subcutaneously inoculated with 2·0 c.c. of blood, containing numerous hæmatozoa drawn from the jugular vein of Horse LXXXIV immediately after death. No swelling followed at the seat of the injection, but on February 14th the muzzle became hot and dry, and there was considerable fever,* lasting several days, but the hæmatozoon was not discovered, although the blood of the animal was collected and examined microscopically three times daily during the period the fever lasted. On the 30th of April, 80 days after the re-inoculation, the hæmatozoon was observed in small numbers and remained in the blood for 48 hours, after which it disappeared and was absent until the 18th July, a period of 78 days, when it was again present in small numbers for one day. From this date until the 29th January 1894, a period of 195 days, the hæmatozoon was never found, although daily examinations of the blood were made. The animal unfortunately met with an accident, broke its leg and consequently had to be destroyed.

The chief points of interest in this case are that,—

(i) This is the first case recorded of any animal of the bovine species having been successfully inoculated with the hæmatozoon of the rat (*Mus decumanus*).

(ii) The amount of swelling and œdema which followed inoculation, at and around the seat of the injection, which finally disappeared on the 14th day after the operation, also the temperature 41·°9 C. (105·°8 F.) registered on the morning of the 8th day.

(iii) The protracted period of incubation of the disease whether we take it as terminating on the first appearance of the urticarial eruption on the 44th day—as previous experience points to the hæmatozoon being the cause of the manifestation in the skin or on the 75th day when the organism was found for the first time in the blood. In either case the length of the latent period, 63 days, has only once been exceeded, viz., in Horse LXII, which was inoculated with soiled rat's blood.

(iv) The discovery of the *Trypanosoma* in the blood on the 76th day after inoculation, when a long and active specimen of the organism was alone observed; the dorsal membrane in which was particularly well developed. The absence of further specimens from the blood during a prolonged period of 121 days.

(v) The marked evening exacerbations and morning remissions of temperature which occurred on the 55th, 56th and 59th days of the disease.

(vi) The loss of flesh during the month which immediately followed inoculation.

(vii) Re-inoculation of the animal with Horse Surra, 197 days after the former injection of soiled rat's blood, followed by high fever, but a total absence of swelling at the seat of inoculation.

(viii) The appearance of the Surra organism in the blood for a period of 48 hours, 80 days later, and re-appearance for 24 hours on the 158th day, but total absence during a further period of 195 days.

Cow No. I.—The experiment determined upon had for its objects—

(i) If Surra is communicated to the cow subcutaneously, does the hæmatozoon or its immature form pass from the general circulation into the milk.

* It is possible that the hæmatozoon was present in very limited number, during the presence of the fever between the 13th and 16th February 1893.

† Two Guinea Pigs inoculated on the 21st September 1892 with blood from this animal in which no hæmatozoon could be discovered, failed to contract the disease.

(ii) Will a calf suckling its mother, under such conditions, contract the disease?

A cow, with a calf three weeks old at her side, contracted Surra.* The blood of the mother was found to contain the hæmatozoon for a period of 120 hours.

The calf was allowed to suckle three times in the 24 hours, and the milk from each teat was daily examined microscopically for the presence of the organism; but this was never discovered. On the 38th day from the appearance of the hæmatozoon in the circulation of the mother, it appeared in the blood of the offspring, which up to that date had been free. The organism remained in the circulation for 24 hours only, and had not re-appeared 123 days later. Blood in small quantities must have become mixed with the milk, owing to rupture of some small mammary vessels and by this means the hæmatozoon entered the digestive tract of the calf.

On February 9th, 1893, the calf having grown considerably and being in good condition, it was decided to re-inoculate it, with a view to ascertain whether the animal had received any protection from the presence of the *Trypanosoma* in its circulation. Consequently, the same evening the calf received subcutaneously 1·0 c.c. of blood taken from the jugular vein of Horse No. LXXXIV immediately after death. No local manifestation followed the injection at the seat of the injection. The latent period occupied a little over 3 days, the hæmatozoon being present for two days, February 13th and 14th and again for one day (18th) after an intermission lasting 72 hours. From the 18th February until September 30th, 1893, a period of 224 days, the organism was present in the blood once and then only for a few hours, *viz.*, on the 22nd June, 123 days after its last appearance.

The animal contracted rinderpest, the first symptom appearing on the 28th, and succumbed to that disease on 30th September 1893.

A similar experiment with the same end in view, as in the case of its offspring, was initiated in the cow. It was re-inoculated on the 9th February 1893, with 2·0 c.c. of blood containing numerous hæmatozoa taken from the jugular vein of Horse No. LXXXIV immediately after death. The latent period occupied 8½ days, no local manifestations being observed at the seat of the injection. From the first appearance of the organism in the blood, on the 18th February 1893, until 31st May 1894, 6 paroxysms, each lasting 1 or 2 days, occurred, the hæmatozoon never exceeding two in a field of the microscope. The length of the intermissions was 10, 29, 70, 9 and 128 days, but as the examination of the blood was discontinued on May 31st, 1894, 214 days since the last appearance of the organism in the blood, it is very unlikely that the hæmatozoon would have again appeared in the circulation. On this latter date the animal was in good health and in very fair condition.

Section III.

Buffalo Surra following inoculation, including the case of Bull No. V at an elevation of 7,500 feet.

Up to the time these experiments were undertaken there was no evidence forthcoming to show whether buffaloes are susceptible to the organism of Surra or not, although it was surmised that if bovines were capable of contracting the disease buffaloes would not be exempt. We had previously shown that bovines passed through an attack of Surra, and if the disease was uncomplicated with any other, the animals always survived, even when re-inoculation was resorted to after varying periods.

In our previous researches, the experiments were conducted more or less in the plains; consequently when these investigations were initiated on buffaloes in the hills, at an elevation of 7,500 feet, it was decided to ascertain concurrently what effect, if any, was produced on bovines by the change of temperature, &c. The opportunity was also taken of working out certain physiological and pathological problems as far as circumstances would permit, on very much the same lines as those adopted in the case of equines, a précis of which was included in the last Report for 1895-96. In order to make this enquiry in bovines and buffaloes, the quantity and composition of the ingesta and egesta have been ascertained during a period of observation previous to inoculation, the incubatory period of the disease, and the paroxysms and intermissions until death. The following data were recorded, *viz*:—

The weight and composition of the *ingesta* including fodder and water, also that of the *egesta* including dung and urine.

In the urine the total nitrogen, the urea, the hippuric acid, and ammonia were separately estimated.

Bull V.—(Hill animal) aged 2 years, was kept under observation from the 27th November 1896 until 15th February 1897. On the 16th February it was inoculated on the ear, a minute incision being made and a trace of blood containing a few hæmatozoa taken from Buffalo I was placed between the edges of the wound. The latent period occupied six days. The hæmatozoon was present in the blood from the 1st to the 3rd of March inclusive. After an interval of three days it was again present in large numbers for four days, March 7th to the 10th; after a second interval of five days it re-appeared for one day on the 16th March. During a further period of 147 days accompanied by daily microscopical examinations of the blood, no organisms were observed. During the period of observation lasting 89 days, the temperature varied between 39·3° and 36° C., and between 38·9° and 37·1° C. during the latent period of the disease. On the appearance of the hæmatozoon, the temperature became rapidly elevated and attained a maximum of 42·5° C. (108·5° F.) on the third evening, and then gradually fell until the morning of the

* During the latent period there was no swelling or œdema observed at the seat of the injection of blood, although a slight thickening could be felt in the subcutaneous tissue.

7th day of the disease when it registered 37·5° C. It again rose to 40·5° C. on the 9th and remained at that point until the evening of the 10th day, when it fell to 37·4° C. The pyrexia since March 11th has been characterized by morning remissions and evening exacerbations especially on the 42nd, 49th, 58th, 102nd, 116th, and 125th day of the disease. During the months of May, June and July this animal became greatly emaciated but by during August commenced to put on flesh and fill out again.

The following Table shows the length of the paroxysms and intermissions registered during the case, together with variation in numbers of hæmatozoa recorded in the paroxysms and temperature during each period. :—

TABLE XXIV.

Period.	Number of days.	Hæmatozoa varied from.	Temperature.		Period.	Number of days.	Hæmatozoa varied from.	Temperature.	
			Maximum °C.	Minimum °C.				Maximum °C.	Minimum °C.
Observation ...	89	.....	39·3	36·0	Paroxysm II ...	4	Few—Swarming.	40·5	37·5
Latent Period ...	6	.....	38·9	37·1	Intermission II.	5	.....	38·6	37·0
Paroxysm I ...	3	Few—Swarming.	41·5	37·4	Paroxysm III .	1	Few—Few...	38·6	37·5
Intermission I ...	3	.....	40·0	37·5	Intermission III.	147	.....	41·0	37·1

Buffalo I, aged 2½ years, was kept under observation for a period of 44 days previous to inoculation (16th Novemoer 1897) on the muffle with a trace of blood containing swarms of Surra hæmatozoa The material was taken from a young cat, which had previously been inoculated from a Surra horse in the plains. No change was observed at the seat of the small incision, between the edges of which the soiled blood was placed. The latent period occupied five days. The time which elapsed between the first appearance of hæmatozoon and death, *viz.* 120 days, was made up of 12 paroxysms lasting 39, and 11 intermissions lasting 81 days. During the course of the disease the animal lost flesh, and towards the last became somewhat emaciated, notwithstanding the voracious appetite which was maintained until two days before death.

The following Table shows the paroxysms and intermissions registered during the case, together with the variation in numbers of hæmatozoa recorded in the paroxysms and temperatures during each period :—

TABLE XXV.

Period.	Number of days.	Hæmatozoa varied from.	Temperature.		Period.	Number of days.	Hæmatozoa varied from.	Temperature.	
			Maximum °C.	Minimum °C.				Maximum °C.	Minimum °C.
Observation ...	44	.....	39·5	35·4	Paroxysm VI ..	3	Few—Few ...	38·2	36·2
Latent period ...	5	.....	38·1	35·4	Intermission VI ...	6	.....	38·3	36·1
Paroxysm I ...	3	Few—Numerous.	39·5	37·0	Paroxysm VII ..	2	Few Few ...	37·7	36·1
					Intermission VII ...	14	.....	38·4	35·2
Intermission I ...	3	.....	38·8	36·4	Paroxysm VIII ...	4	Few—Numerous.	38·2	36·9
Paroxysm II ...	6	Few—Numerous.	39·6	35·8	Intermission VIII .	8	.....	38·5	37·0
Intermission II ...	5	.....	38·5	35·9	Paroxysm IX ...	2	Few Few ...	38·0	36·9
Paroxysm III ...	2	Few—Numerous.	39·4	36·4	Intermission IX ...	14	.....	38·2	36·2
					Paroxysm X ...	3	Few—Very Numerous.	37·4	36·2
Intermission III ...	8	.....	39·0	36·0					
Paroxysm IV ...	4	Few—Few ...	38·2	36·2	Intermission X ...	7	.....	39·2	36·2
Intermission IV ...	6	.....	38·6	35·5	Paroxysm XI ...	5	Few—Numerous.	38·6	36·1
Paroxysm V ...	2	Few—Few ...	37·5	36·0					
Intermission V ...	5	.....	38·0	36·0	Intermission XI ...	5	.....	37·4	36 0
					Paroxysm XII ..	3	Few—Swarming.	36 8	35·1

Autopsy.—At 1 P.M , 2 hours after death. Body weight 267 lbs. The body is somewhat emaciated, and *on section* no subcutaneous adipose tissue is seen. The lymphatic glands in the neck are somewhat increased in size. The pleural cavities are free from fluid and there are no pleuritic adhesions. The *lungs* are fully distended with air, the left organ being the seat of hypostatic congestion. *On section* the tissues present a healthy appearance. There are 15 cubic centimetres of a clear straw-coloured fluid in the pericardial sac.

Heart.—The base is surrounded with a semi-solid jelly, in place of the fat, usually found in that position. The external surface of the organ is free from extravasations of blood or small petechiæ. *On section*, the internal surface of the endocardial lining is free from extravasations, and the valves are healthy.

The peritoneal cavity is free from fluid.

Liver, weighs 3 lbs. 13 ozs., somewhat small. Glisson's capsule free from old or recent signs of inflammation, so frequent in equines which have succumbed to Surra. *On section* the tissues present a healthy appearance.

Spleen weighs 14 ozs., normal in size and consistency; *on section* tissues present a healthy appearance.

Kidneys.—Right weighs 6 ozs., left 6 ozs. The capsules strip easily. *On section* tissues healthy in appearance.

Rumen, Reticulum, Omasum and Abomasum.—Healthy.

Large and small Intestines present healthy appearance.

Stomachs and Intestines with dung weigh	...	... 86 lbs.
Stomachs and Intestines without dung weigh	...	... 22 „
Weight of contained dung	...	64 „

Buffalo II, aged 3 years, was kept under observation for a period extending over 45 days, previous to the commencement of the experiment. On January 14th, 1897, the animal was inoculated with Surra in the ear. For this purpose a minute incision was made in the skin, covering the top of the right organ; and a minute drop of blood containing a few hæmatozoa taken from Buffalo No. I was inserted between the edges of the wound. No local manifestations of any kind were observed to follow the inoculation, but on the morning of the 20th, after a latent period of a little over five days, the hæmatozoon appeared in small numbers in the blood. The time which elapsed between the first appearance of the hæmatozoon and death, *viz.* 46 days, was made up of seven paroxysms lasting 15, and seven intermissions lasting 31 days. During the course of the disease the animal lost flesh, and before death took place became emaciated, in spite of the appetite which was present until several days before the animal succumbed.

The following table shows the length of the paroxysms and intermissions registered during the case, together with the variation in numbers of hæmatozoa recorded in the paroxysms and temperature during each period:—

TABLE XXVI.

Periods.	No. of days.	Hæmatozoa varied from.	Temperature.		Periods.	No. of days.	Hæmatozoa varied from.	Temperature.	
			Maximum. °C.	Minimum. °C.				Maximum. °C.	Minimum. °C.
Observation ...	45	...	39·2	35·0					
Latent Period ...	5	...	38·4	36·0	Paroxysm IV ...	1	Few ...	37·5	37·1
Paroxysm I ...	1	Few ...	38·4	37·6	Intermission IV ...	9	...	38·2	36·5
Intermission I ...	2	...	39·0	36·0	Paroxysm V ...	1	Few ...	37·1	36·8
Paroxysm II ...	2	Swarming	40·0	36·0	Intermission V ...	8	...	38·4	36·2
Intermission II ...	4	...	39·0	36·0	Paroxysm VI ...	2	Few ...	38·0	36·6
Paroxysm III ...	4	Few—Numerous.	37·9	36·5	Intermission VI ...	4	...	38·4	36·4
					Paroxysm VII ...	4	Few ...	37·8	36·2
Intermission III ...	1	...	37·9	36·5	Intermission VII ...	3	...	37·2	36·0

Autopsy, 11 A.M., 12 hours after death.

Two leeches came out from the nostrils shortly after the death of the animal.

The body is somewhat emaciated and, *on section*, there is an entire absence of subcutaneous adipose tissue.

Thorax.—The pleural cavities contain a small amount (30—40 c. c.) of a semi-opaque fluid. There are no pleural adhesions.

Lungs weigh 4 lbs. 6 ozs., are fully distended with air; slight emphysema left anterior lobe.

The pericardial sac is distended with a light yellow-coloured clear fluid.

Heart weighs 1 lb. 12 ozs. The base is surrounded with a semi-solid jelly in place of the fat usually present in that position. External surface of the organ presents a healthy appearance.

Right Auricle.—Healthy.

Right Ventricle contains decolourised clot running up into the pulmonary artery. No sub-endocardial extravasations.

Left Auricle.—Healthy.

Left Ventricle.—Contracted; decolourised clot. No extravasations.

The peritoneal cavity contains a small quantity—55 c. c.—of clear, straw-coloured fluid.

Liver weighs 3 lbs. 11 ozs., surface and tissues on section present a healthy appearance.

Spleen weighs 10 ozs., small, healthy.

Kidneys.—Right weighs 6 ozs., left 6·25 ozs. Capsules strip easily. Tissues appear healthy.

Rumen, Reticulum, Omasum.—Healthy. The Abomasum or true stomach, *on section*, presents elongated narrow patches of a deep chocolate colour $\frac{1}{6}''$ in width, dotted over the whole surface of the mucous membrane. This deposit, when carefully scraped, appears to leave the mucous-membrane beneath unaltered.

Small and Large Intestines.—Here and there the vessels are injected in their whole length, occasionally patches 2″ in width are observed, deep red in colour, also due to capillary injection. No ulceration.

Bladder.—Healthy.

Weight of dry dung in intestines	...	62·75 lbs.
„ „ fluid „ „ „	...	5·50 „
Total weight of dung	...	68·25 lbs.

Although horses which contract Surra from inoculation with the hæmatozoon of the rat (*Mus decumanus*) succumb within a limited number of hours to a very virulent form of the disease, bovines suffering from the same malady, derived from a similar source, pass through a varying number of short paroxysms and prolonged intermissions, and concurrently become considerably emaciated. Eventually, after some months, these animals throw off the disease, and again attain a robust condition of body.

It would appear that the blood of bovines, after inoculation with the Surra *Trypanosoma*, must contain for a considerable period the Surra organism or its immature form. For Guinea Pigs inoculated with the blood from an animal (Bull I), on the 76th and 154th days of an intermission respectively succumbed to the disease, although no hæmatozoa could be discovered in the inoculated blood. Animals of the same species succumbed after passing through a period of incubation lasting 14 days, when inoculated with blood from an animal (Bull III) taken on the 18th day of an intermission.

Bovines when inoculated with blood containing the Surra *Trypanosoma* primarily derived from either the horse or rat, present during a varying period (5 to 14 days) a considerable amount of swelling and œdema with tenderness at the seat of the injection. On re-inoculation, however, with material derived from either of the above sources, no local manifestations are observed to follow the operation.

During the case of Bull No. III, inoculated on the first occasion with Horse Surra blood and on the last with material primarily derived from the rat but passed through the horse, the seat of inoculation became very irritable on the day previous to the occurrence of the second and third paroxysms. An observer, therefore, was able to recognise when the Surra organism was about to reappear in the blood of the animal.

Table XXVII.

Showing the number of Paroxysms and Intermissions which occurred in the course of each case together with their duration and other details connected with the cases.

No.	Animal.	1st or 2nd Inoculation.	Period of observation. Date. From.	To.	No. of days.	Fluid used.	Quantity used.	Fluid taken from what animal.	Hæmatozoa.	A. M. or P. M.	Date of Inoculation.	How administered.	Date of First appearance of Hæmatozoa.	Latent period, length in days.	P.	I.	PII.	III.	PIII.	IIII.	PIV.	IIV.	PV.	IV.	PVI	IVI.	PVII.	IVII	Ps. Total No. days.	Is. Total No. days.	Result.	Date of Result.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16														17	18	19	20
I ...	Bull ...	1st..	19th Mar. 91	24th Mar. 91	5	Blood ...	1·75 c.c. ...	Horse XIX...	N.	...	24th Mar. 91	Sub-cut. ..	29th Mar. 91	5	1	1	2	507	...	...	..	...	...	...	...	...	...	...	3	503	...	.....
,, ...	,, ...	2nd .	....	.. ..	...	,, ...	1·0 ,, ...	Donkey II...	V.N.	A.M.	12th Aug. 92	,, ..	Nil	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	.....
III ...	Bull ...	1st..	24th July 92	31st July 92	7	Blood ...	1·0 ,, ...	Horse LXVII ...	V.N.	,,	31st July 92	,, ..	3rd Aug. 92	3	7	13	2	9	1	158	...	...	...	...	...	...	...	...	10	180	...	.....
,, ...	,, ...	2nd .	.....	.....	...	,, ...	2·0 ,, ...	,, LXXXIV...	N.	P.M.	9th Feb. 93	,, ...	30th Mar. 93	49	1	109	3	9	3	58	...	...	...	...	...	...	...	...	7	176	Death ...	28th Sep. 93
IV ...	Bull ...	1st..	24th July 92	27th July 92	3	,, ...	2·0 ,, ...	Rat (M. Decu.) ...	N.	,,	27th July 92	,, ..	11th Oct. 92	75	1	121	...	...	...	...	...	...	...	...	...	...	...	...	1	121	...	.....
,, ...	,, ..	2nd .	.....	.....	...	,, ...	2·0 ,, ...	Horse LXXXIV..	N.	,,	9th Feb. 93	,, ...	30th Apr. 93	5?	1?	73	2	77	1	195	...	...	...	...	...	...	...	...	4	345	Killed ...	29th Jan.. 94
I ...	Cow ...	1st..	24th Aug. 92	28th Aug. 92	4	,, ...	1·0 ,, ...	Donkey II...	V.N.	A.M.	28th Aug. 92	,, ...	2nd Sep. 92	5	5	55	1	18	1	21	2	58	...	..	...	...	...	...	...	9	152	...	.....
,, ...	,, ...	2nd .	.....	.....	...	,, ...	2·0 ,, ...	Horse LXXXIV...	N.	P.M.	9th Feb. 93	,, ...	18th Feb. 93	9	1	10	1	29	2	70	1	3	1	128	2	214	...	...	8	460	Cured ...	.....
I ...	Calf ...	1st...	24th Aug. 92	28th Aug. 92	4	Milk ...	Ad libitum ...	Cow I...	?	A.M.	2nd Nov. 92	Gastric Inj....	9th Oct. 92	?	1	123	...	...	...	...	...	...	...	...	...	...	...	...	1	123	...	.....
											9th Oct. 92																					
,, ...	,, ...	2nd .	.....	.....	...	Blood ...	1·0 c.c. ...	Horse LXXXIV...	N.	,,	9th Feb. 93	.....	14th Feb. 93	4	2	3	1	123	1	100	..	...	...	...	...	...	...	...	4	226	Death ...	30th Sep. 93
V ..	Bull ...	1st...	26th Nov 96	16th Feb. 97	89	Blood ...	m i ...	Buffalo II...	F.	,,	22nd Feb. 97	Sub-cut. ...	1st Mar 97	6	3	3	4	5	1	147	...	...	...	..	...	...	...	...	8	155	Cured ...	.....
															3	3	6	5	2	8	4	6	2	5	3	6	2	14	39	81	Death ...	21st Mar. 97
I ...	Buffalo...	1st...	4th Oct. 96	17th Nov. 96	45	Blood ...	m ii ...	Cat VI...	S.	,,	16th Nov. 96	Sub-cut. minute incision.	22nd Nov. 96	5	P v	iii I	P ix	I x	P x	I x	P xi	I xi	P x	ii								
															4	8	2	14	3	7	5	5	3	...	...	...	..	...				
II ...	Buffalo...	1st...	1st Dec. 96	14th Jan. 97	45	Blood ...	m i ...	Buffalo I...	F.	,,	14th Jan. 97	In minute incision.	20th Jan. 97	5	1	2	2	4	4	1	1	9	1	8	2	4	4	8	15	31	Death ..	5th Mar. 97

Bull I.—On 27th August 1892—Organism was observed in the blood resembling a very large Surra *Trypanosoma*, the length was equal to the diameter of 1¼ red blood corpuscles, and its width at the widest part equal to that of 2·5 to 3 red corpuscles. A round nucleus or vacuole was readily discernible in the protoplasm of the dilated portion of the organism. The body remained almost motionless, whilst the long flagellum was twisted and twirled, lashing the corpuscles to right and left. At a later period the undulating membrane became very distinct.

Cow I.—On November 7th 1892—June 15th, July 3rd, September 2nd 1893, a single example of the hæmatozoon, similar to the one found in the blood of Bull I, was observed. Two guinea pigs inoculated with the blood in June, died in 7 and 9 days respectively, but no large hæmatozoa were discovered in their blood, although the small variety of organisms were swarming.

Bull No. III.—This animal, on September 26th, 1893, the 56th day of Intermission III, developed rinderpest spontaneously. Death followed on the 28th September.
Two guinea pigs inoculated on 21st September 1892 with 0·3 c.cm. of blood in which no hæmatozoa could be discovered microscopically, contracted Surra after a latent period of 14 days.

Bull No. IV.—This animal, on the 29th January 1894, the 195th day of Intermission III, met with an accident, which necessitated its being destroyed.
Two guinea pigs inoculated on September 1892 with blood from this animal, in which no hæmatozoa could be discovered, failed to contract the disease.

Calf No. I.—This animal, on 28th September 1893, the 98th day of Intermission III, developed rinderpest spontaneously, and death followed on the 30th September.

HÆMATOZOON OF THE RAT.

B 2201—23

SECTION I.

Historical References.

Gros * observed minute worms (vermicules) in the blood of a field-mouse (mulót) which were so numerous as to cause the blood to present an animated appearance; and that the blood of the mole was often found to be in a similar condition. The vermicules were barely visible when magnified 400 diameters.

Chaussat † observed on many occasions in the blood of the black rat (*Mus rattus, Lin.*) microscopic animalcules having the form of Filariæ; their movements were very rapid.

These parasites were seldom if ever observed in the blood of young rats, but were almost always seen in adults.

Chaussat appeared to consider them to be Nematodes, but we do not doubt that they are very analogous to, if not identical with, the organisms in question; the same remark is applicable to those hæmatozoa mentioned by Gros.

‡ *Butschli* "found a flagellated parasite which he has often observed in the intestinal canal of a free nematode (*Trilobus gracilis*). He refrains from giving it a name owing to the uncertainty which exists with regard to organisms of this kind. He generally found them in large numbers, often forming stellate colonies owing to their being attached by their non-flagellated ends. They readily became detached and then presented a somewhat spindle-shaped body, about ·011 m.m. in length and with a somewhat thick flagellum about double this length, so that the total length of the protozoon would be ·033 m.m., something more than half of the length of the flagellated organism found in the rat's blood. Near the base of the flagellum of Butschli's protozoon a contractile vacuole could be distinguished."

When Dr. T. R. Lewis § was detailed to make investigations into the etiology of Spirillum or Bombay fever in July 1877, he had occasion to examine the blood of a considerable number of animals. He then detected organisms in the blood of the rat which he took to be vibrios or spirilla. On microscopical examination the blood "seemed to quiver with life." Two species of rats harboured these parasites *Mus decumanus* and *Mus rufescens*, but although Lewis examined the blood of a large number of mice, he never detected organisms nor did he see them in any animals other than rats.

He found the organism present in rats examined in Calcutta and also at Simla in the Himalayas at an elevation of 7,500 feet. The animals thus affected were kept in cages for weeks by him and they remained to all appearance in a state of perfect health. At one time Lewis was inclined to think that the organisms might be Spermatozoa of some parasite hidden in the tissues of the rat, as he had observed several years previously Spermatozoids very much resembling the hæmatozoon escaping from the reproductive pore of a segment of tænia obtained from that animal.

At a later date, 1880, when Evans discovered the presence of organisms in the blood of horses and camels suffering from Surra in the Punjab, and further found that the disease was capable of reproduction by inoculation in the horse and dog, Lewis satisfied himself that the parasite in the dog was identical with that in the rat.

With regard to the health of the rats in which these flagellated organisms were detected, Lewis says: "There was nothing to suggest in any way that they were less healthy than others not so affected, and I have repeatedly kept rats for a considerable time for the purpose of observing whether any special symptoms would be manifested suggestive of the existence of such organisms in the circulation. It frequently happened that the rats caught in a particular room would be affected, whereas the blood of rats in another part of the building would not contain them."

"They were pale, translucent beings, without any trace of visible structure or granularity; but as their movements were so rapid, exact information as to their microscopical character could not be ascertained at the time. The slides were therefore placed under a bell glass until these should diminish."

On the following morning the activity of the filaments was much less. Their movements were more restricted and more undulatory in character, and the blood corpuscles having become somewhat agglutinated, had apparently squeezed out the organisms, so that the latter occupied the serum areas of the preparations. It was eventually observed that this movement was due to the existence of a very long and exceedingly fine flagellum, apparently a posterior flagellum, as the organisms seemed generally to move with the thickened end forwards—the flagellum being seen following it, and lashing the fluid during the movement, it remained in focus. I have not been able to detect any flagellum at the opposite end. They may sometimes be kept alive for two or three days, but generally the greater portion will have died within 12 to 24 hours: and not only have died, but also disappeared from view.

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* Gros.—Referred to by Bastian, "Beginnings of Life." Vol. II. Pg. 338, 1872.

† Chaussat.—Des hæmatozoaires, Thése. 1850, Paris; also
Dict: Encyclop: des: Science: Med Dechambre et Lereboullet.

‡ Butschli.—Zeitschr fur Wissentsch Zoologie Band XXX. Heft 2 Taf XI, fig. 9 Jan. 1878.
"Microscopic Organisms in Blood of Man and Animals."

§ Lewis, T. R.—Appendix 14th, Annual Report of Sanitary Commissioner with the Government of India, 1878.
"Quarterly Journal of Micros: Science," Vol. LXXIII, page 109, 1879.
"Further Observations on Flagellated Organisms in the Blood of Animals," 1884.

when carefully watched; the plasma constituting the thicker portion of their substance may be seen suddenly to swell out at certain places, sometimes so as to divide the body into two parts. At other times two or three such constrictions and dilatations may be detected, the dilatations being possibly observable only on one side, at other times they assume an arrow-shaped aspect. Occasionally something like granularity may be observed before their disappearance, but not a trace of them is left after their disintegration: it seems as though they had been dissolved in the serum in which they were found.

The width of the anterior half or body portion averages ·008 to ·001 m.m. and its length from ·020 to ·030 m.m. or an average of ·025 m.m. The flagellum, so much of it as is visible, is somewhat of the same length, so that the total length of the organism equals about ·050 m.m. or $\frac{1}{500}$". The last, however, may be considerably longer than this, as the slope from the body portion is very gradual, and when the eye follows it to the bounds of visibility, an impression is conveyed that there may be still more of it, beyond the power of either Ross $\frac{1}{12}$" or Powell and Lealand's $\frac{1}{16}$" to reveal.

*Wittich** described similar organisms in the blood of badgers in Germany.

Wittich's observations coincided with Lewis' as regards their being found in the blood of apparently perfectly healthy animals, though Koch† found that the hamsters which he procured died, one within two days of being in captivity, and four others subsequently. It does not appear that the blood of these hamsters was examined during life, but after death it was found, in each case, to contain the organism in question. No reference is made to the examination of other hamsters, so that it is not quite clear whether the animals died as a result of captivity or in consequence of the parasitism. Both Wittich and Koch suggest that the parasites found by them in the blood of hamsters are in all probability identical with those found by Lewis in India.

‡ Crookshank in 1886 examined the blood of a few white rats for hæmatozoa but without success, and then proceeded to obtain a large number of brown rats from the London sewers, and ascertained that the blood of no less than 25 per cent. of these apparently healthy animals contained these active organisms. After careful observations of the organisms, Crookshank came to the following conclusions:—

"They are polymorphic, presenting for the most part slightly tapering bodies which terminate at one end in a stiff, immobile, acutely-pointed flexible filament or spine-like process, and at the opposite end are provided with a long flagellum, which longitudinally attached a delicate undulating fin-like membrane can be traced, which starts from the base of the posterior filament, and becomes directly continuous with the flagellum. The body is found to be distinctly granular, with one or more highly refractive spherules. When the rapid movement is arrested the undulating membrane is distinctly visible. The organism moves in the direction of the flagellum, the flagellum threading its way between the corpuscles and drawing the rest of the organism after it."

Carter's§ observations on rats were chiefly of the species *Mus decumanus* and *Mus rattus*, the small brown or grey rat being oftenest infected. A few examples examined of *Mus bandicottus* and of *Sorex* species (also of mice) gave negative results. Males were the most numerous; in pregnant females the fœtus was not implicated: the animals were active, non-febrile, and bearing injuries incidental to capture, all seemed alike healthy, so that one could not surely guess beforehand the state of their blood. Animals fed upon wheaten bread, rice and water *ad libitum*. The temperature was taken twice or thrice daily *per rectum*, and usually in control-animals as well as those under experiment. From 99° F. A.M. to 101° F. P.M. (37·3°—38·4° C.) seemed to be the common range under conditions stated, but degrees somewhat higher and lower were occasionally noted attributable perhaps to excitement or exhaustion.

Of 60 rats caught in February, 9 (15 per cent.) showed the *Trichomonas*. Of 150 rats caught in August to December, 16 (10 per cent.) were found infected. Inclusive proportion showing the hæmatozoon, nearly 12 per cent., which is less than one-half of the percentage found in Calcutta and London.

There was no pronounced or constant differences in the rectal temperature of infected rats as compared with the non-infected. No striking corresponding change of temperature was ever noted when it happened that the monads disappeared suddenly from the blood.

A common lesion amongst animals kept was atrophy and necrosis of the tail, then usually the feet became swollen and finally there were signs of paralysis.

Fifteen special autopsies were made, of which nine of rats showing the hæmatozoon, and in none of them did I see any peculiar coarse lesion of the blood or vicera or tissues of the trunk. Microscopically, the only change noted was an increase of leucocytes; the spleen elements seemed normal. As seen in the freshest blood their movements are so rapid as to be followed with difficulty by the eye, certain optical impediments concurring thereto; yet, evidently, the chief one is that of progression more or less direct, and accompanied by a lateral lashing or sometimes an apparent rotation. Progression may doubtless be either backward or forward and misled by the idea of the thicker end being the head of the

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* Wittich.—Spirillen im Blut von Hamstern. Centralblt-f-Med. Wiss 1881. No. 4.

† Koch.—Mitteilungen ans der Kaiserlich Gesundheitsamte Vol. I, 1881, p. 9.

‡ Crookshank, E. M., M.B.—Flagellated protozoa, &c. *Journal of the Microscopical Society, 1886.*

§ *H. Vandyke-Carter*, M.D., "On the lately demonstrated blood contamination and infective disease of the Rat and Equines in India." Scientific Memoirs by Medical Officers of the Army of India, Vol. IV, 1887.

organism. I, like Dr. Lewis, gained the impression that it commonly advanced; yet it is certain that when more tranquilly performed, progression is really with the flagellate extremity in front, as is usual in the other infusorial monads.

Inoculation experiments.—These were as follows: the subcutaneous injection of healthy animals with tainted blood of the rat: the animals so employed being the rat, dog, cat, horse, and monkey; also the intra-peritoneal injection of a healthy rabbit and a healthy monkey. The last named attempt proved alone successful, but it may be useful to offer a brief record of the whole series of trials:—

(*a*) Experiments on rats:—1 and 2. A fragment $\frac{1}{10}$ square inch large of fresh blood-clot was introduced beneath the skin of the thigh of two animals with seemingly healthy blood. Second day the blood of both preserves its normal aspect: so on the third, fourth, fifth, sixth, and seventh day. One rat now escaped; the other continued well and was submitted to observation daily until the sixteenth day, when, the result being so far negative, it was killed and inspected without the detection of special morbid change. 3. A similar fragment of blood-clot from the heart of rat which had just died with flagellate organisms still persisting in the circulation was introduced beneath the skin of the thigh of an animal with healthy-looking blood. Evening temperature 101°; the animal looks well: second day morning temperature 101·8°; the blood unchanged; evening temperature 102·4°, no change and no evident constitutional irritation with this rise: third day morning temperature 101·8°, nil; evening temperature 102·4°, nil: fourth day morning temperature 100·6°, nil, evening temperature 101·6°, nil: fifth day morning temperature 100·4°, nil, evening temperature 101°, nil: sixth day morning temperature 100·4°, nil, evening temperature 101·4°, nil: seventh day morning temperature 100°, nil, evening temperature 101·6°, nil: eighth day morning temperature 100°, nil, evening temperature 101·6°, nil: ninth day morning temperature 99·8°, evening temperature 101·2°: tenth day morning temperature 100°, nil, evening temperature 100°: eleventh day morning temperature 100°, nil; evening temperature 101·2°; and the animal continued well for five days longer.

(*b*) Experiments on the dog:—1. A healthy white puppy, a month old, had a few minims of fresh rat's blood containing several monads injected in the thigh: evening temperature 100·6°; no irritation of wound: second day morning temperature 100·6°; blood unchanged; evening temperature 101°, nil: third day morning temperature 100°, evening temperature 101·2°, nil: fourth day morning temperature 99°, nil, evening temperature 100·6°: fifth day morning temperature 100·4°, nil, evening temperature 101°: sixth day morning temperature 99·6° and evening temperture 100°, nil; and so on for five days longer. 2. A healthy black male pup was injected with similar blood; evening temperature 101·4°; nothing morbid visible in its blood: second day morning temperature 101°, nil, evening temperature 100°, nil: third day morning temperature 99°, evening temperature 101·4°, nil: fourth day morning temperature 100°, nil, evening temperature 101°: fifth day morning temperature 101·4°, nil, evening temperature 100·4°; sixth day morning temperature 100° and evening temperature 100·4°, nil; and so on for six days longer.

(*c*) Experiments on the cat:—1. A large black healthy male; evening temperature 101°; had inoculated at inner surface of thigh a minute clot of rat's blood filled with active organisms; second day morning temperature 98°; was again inoculated with a small clot from another rat just killed, which contained many monads, this being done to ensure thorough trial; evening temperature 100°, nil; third day morning temperature 98°, blood nil, the wounds scarred; evening temperature 102°; animal feverish, but eats heartily and sites of inoculation not inflamed; a few large granule-cells observed in the blood: fourth day morning temperature 98°; nothing abnormal seen in the blood except a few large granule-cells; evening temperature 101·6°; nothing abnormal in the blood but some large plasm-particles and a few large granule-cells: fifth day morning temperature 99°, nil, evening temperature 101°, nil; sixth day morning temperature 98°, nil, evening temperature 101°, nil; seventh day morning temperature 99°, nil; evening temperature 99°; eighth day morning temperature 100°: nil, evening temperature 101·6°: ninth day morning temperature 99° and evening temperature 100·6, nil; for five days longer the temperature remained normal. 2. A healthy fawn-coloured small cat; evening temperature 101·4°, had inoculated in the thigh on point of scalpel a minute clot of blood from a rat which contained the monads: second day morning temperature 99°; blood unchanged; evening temperature 100·2°; white cells many in the blood, which seemed poor in quality; third day morning temperature 99°, nil, evening temperature 100·6°, nil, white cells many: fourth day morning temperature 99°; only leucocytes and small plasm-particles unusual; evening temperature 101·6°, leucocytes and large plasm-particles; fifth day morning temperature nil, blood healthier looking, evening temperature 99°, nil; sixth day morning temperature 99°, nil, evening temperature 101·6°, nil: seventh day morning temperature 98°, evening temperature 103°, animal feverish, in its blood nothing unusual, but many white cells and no other apparent cause of the fever; eighth day morning temperature 100·4°, nil, evening temperature 100·6°: ninth day morning temperature 100·4° and evening temperature 101·4°, nil: for five days longer the temperature normal.

(*d*) Experiments on monkeys:—1. A small fresh-brought healthy animal; had at 10 A.M. injected minims xx of infected blood of rat just before killed on each side of thighs; temperature 102°: at 5 P.M. temperature 103°, nothing abnormal seen in the blood; wounds unchanged; animal quiet: second day morning temperature 100·4°; nothing abnormal in the blood, evening temperature 101·6°, nil; third day morning temperature 101° and evening temperature 102°, no visible change in blood, but animal seems oppressed; fourth day morning temperature 100°, nil, evening temperature 101·4°,

nil; fifth day morning temprerature 100·6°; nothing unusual in the blood, but some granule-cells, evening temperature 101·8°, nothing but some plasmic particles: sixth day morning temperature 100·4°, nil, evening temperature 100·4°, nil; seventh day morning temperature 100°, nil, evening temperature 101·8°, nil; eighth day morning temperature 99° and evening temperature 101°: ninth day morning temperature 100°, nil, evening temperature 101°; tenth day morning temperature 100·4 and evening temperature 101°, nil; and for five days more temperature remained normal.

2. A larger monkey, healthy as regards temperature and blood, had injected minims xx of fresh-drawn blood of rat containing many monads; evening temperature 101·6°. its blood unchanged; second day morning temperature 99°, nil, evening temperature 101°, nil; third day morning temperature 99°, nil, evening temperature 101·6°, nil; fourth day morning temperature 100°, evening temperature 101°, nil; fifth day morning temperature 100°, nil, evening temperature 101·6°, nil; seventh day morning temperature 100°, nil, evening temperature 100·6°: eighth day morning temperature 99·4° and evening temperature 100°, nil; for five days longer a normal temperature.

These observations were made by myself in the month of February.

(*e*) Experiments on equines:—These I was unable to carry out personally, but considering it particularly desirable to ascertain if the seemingly harmless rat-infection could be communicated to the horse, in which animal an apparently similar parasitism of the blood is attended with the symptoms of serious illness, I forwarded on different occasions, towards the close of 1885, several Bombay rats, having the hæmatozoon in their blood, to my friend Mr. J. H. Steel, A. V. D., then at Poona in the Deccan, with a request that he would be good enough to inoculate horses, as occasion offered, with the blood of these rats in the same manner as had been successfully done in Burma with the blood of equines suffering from the 'Surra' disease. And in January 1886, I received an interesting record, from which the following extracts are made:—

(1) At midday infected rat's blood mixed with water was injected subcutaneously in the region of the neck and also into the peritoneal cavity of a horse; about 80 minims being injected at each site: at 2-20 P.M. temperature 101·9°, and no organism detectible in the horse's blood: next day there was observed a diffuse painful hard swelling at both sites of injection and the patient seemed a little feverish and excitable: these symptoms subsided and the animal was subsequently lost sight of.

(2) An aged horse had inoculated subcutaneously some infected rat's blood mixed with water: tumefaction occurred at the site of inoculation and no other result is mentioned.

(3) The blood of a rat mingled with lukewarm water was injected subcutaneously in a mare and a pony. The mare received 80 minims in front of the right shoulder: on the following day marked swelling was perceptible at the spot, which however speedily declined until hardly perceptible on the ninth day: slight irregularities of the temperature were noted on two occasions, and up to the nineteenth morning, when observation ceased, no spirilloid could be found in the mare's blood, which had been daily inspected: some weeks later the animal continued in good health. The pony received at several punctures in the neck altogether about 90 minims of mixed rat-blood and water: and for the nineteen days ensuing there were noticed only some slight perturbations of temperature, slight swelling at the sites of inoculation subsiding on the fourth day, and an absence on each day of any visible contamination of the blood of the pony, which some weeks later continued in good health.

(4) A chesnut pony mare in good condition received in each jugular vein about 65 minims of blood from a rat mixed with tepid water—this blood teeming with very active organisms: a smart rise of temperature occurred seven hours afterwards; there was no local swelling, and no parasite could be detected in the blood of the pony on the first, second, third, fourth, and sixth day of experiment, nor at a later date was any positive result communicated.

Regarding these trials ending thus negatively, Mr. Steel remarks that "although the amount of rat's blood used in each case has been very small, it is to be remembered that an equal amount of blood from an infected mule would convey the 'Surra' disease to a healthy mule by either of the methods of administration adopted."

(*f*) In September 1885, I made the following essays of intra-peritoneal inoculation, the subcutaneous method having hitherto failed. Rat's blood containing numerous monads promptly taken from the heart and diluted with an equal part of warmed salt solution was introduced by syringe to the amount of 5 minims into the peritoneal cavity of a rabbit and a monkey whose blood was previously ascertained to present normal aspect.

(1) Rabbit, young; evening temperature 101·6°; second day morning temperature 101·4°; no change in the blood twice examined, evening temperature 102·2°; animal seems irritated, its blood unchanged; third day morning temperature 100·4°, nil, evening temperature 102·6°, nil: fourth day morning temperature 101·4°, nil, evening temperature 101°, nil, fibrine and white cells scanty: fifth day morning temperature 100°, nil, evening temperature 101·4°, nil; sixth day morning temperature 100°, nil, evening temperature 100° nil, animal lively; seventh day morning temperature 101°, nil, evening temperature 102°; eighth day morning temperature 100·6° nil, evening temperature 101·8°; ninth day morning temperature 100·4°, nil, evening temperature 101·6°; tenth day morning temperature 100·4°, nil, evening temperature 100·4°; eleventh day morning temperature 100·4°, nil, evening temperature 101·4°; twelfth day morning

temperature 100·2,° nil, evening temperature 101°; thirteenth day morning temperature 100·4°, nil, evening temperature 101·6°; fourteenth day morning temperature 100°, nil, evening temperature 101°; fifteenth day morning temperature 99·8°, nil, evening temperature 100°; sixteenth day morning temperature 99·6°, nil; and for a few days longer similar negative results.

(2) A small monkey (*Macacus radialus*) with healthy aspect and blood; morning temperature 101°, possibly not all the injected material reached the peritoneal cavity, as the blood had coagulated and it may have been blood serum chiefly which penetrated deeply; second day morning temperature 100°; 18 hours after experiment the animal seems well, no local swelling, but abdomen slightly tender at site of puncture to the right of the navel; in the first sample of blood taken from a digit 2 monads were detected very actively moving and otherwise presenting all the aspects of the hæmatozoon seen the day previously in the rat; they kept near to each other and were long watched: temperature at 1 P.M. was 100·6°, at 5 P.M. temperature 102°; another active organism was seen in a fresh specimen of the blood from another digit: temperature at 9 P.M. 100°: third day morning temperature 101°; a specimen of the blood now taken showed a single active monad: at 1 P.M. temperature 100·6°, at 5 P.M. temperature 102°; a flagellate organism like that of the rat was again found in the blood, as before: at 9 P.M. temperature 100·2°; fourth day morning temperature 101·4°; I failed to detect any parasite; evening temperature 101·6°; no parasite seen, but much plasmic matter and many white cells; at 9 P.M. temperature 99·6°; fifth day morning temperature 100·4°, nil, evening temperature 102°; plasmic particles small, many: at 9 P.M. temperature 100°; sixth day morning temperature 100·6°, nil, at 1 P.M. 100·4°, at 5 P.M. temperature 101°, nil, at 9 P.M. temperature 100°; seventh day morning temperature 100·4°, nil, evening temperature 101·6° and later 99·6°; eighth day morning temperature 100·2°, nil, but many plasmic particles, evening temperature 101·4° and 99°; ninth day morning temperature 100·4°, nil, evening temperature 101·4° and 99·6°; tenth day morning temperature 100·2°, nil, evening temperature 102°, at 9, P.M. temperature 100°: eleventh day morning temperature 100·8°, evening temperature 101·6° and 99·6°; twelfth day morning temperature 100·4°, nil, evening temperature 101·6° and 99·4°; thirteenth day morning temperature 100·4°, nil, evening temperature 102° nil; at 9 P.M. temperature 100°; fourteenth day morning temperature 101°, nil, evening temperature 102° and 99·6°; fifteenth day morning temperature 100·4° nil, evening temperature 101·6° and 99·8°; sixteenth day morning temperature 100·4°, nil, evening temperature 101·6° and 100°; seventeenth day morning temperature 100·4°, nil; and subsequently this animal long remained well.

SECTION II.

Precis of Experimental Cases.

(*a*).—Subcutaneous inoculation with soiled rat's blood.

Results Positive—Horses Nos. IX, XXVIII, XLII, LXII.

Horse No. IX.—Bay Australian Gelding, aged 15 years, inoculated subcutaneously on the 28th December 1890 with 1·0 c.c. of blood containing hæmatozoa, taken from the heart and great vessels of a rat (*Mus decumanus*) immediately after death. The latent period was nineteen days. Considerable swelling and œdema was present at the seat of inoculation accompanied by tenderness on manipulation. The temperature from the day of inoculation to the morning of the fourteenth day after, oscillated between 39°C., and 36·4°C., but from the evening of the latter date, when it registered 36·6°C., until the first appearance of the hæmatozoon, the temperature gradually rose day by day until it reached 39·3°C. But from the first day until death, which occurred on the twentieth day of the disease, the fever was of a continued type with exacerbations reaching 41·3°C., 40·8°C. and 40·1°C. on the 3rd, 8th and 13th days of the disease respectively.

Autopsy.—Body fairly nourished. *Lungs.*—Localized emphysema at both apices and a few sub-pleural extravasations. The pericardial sac contained a considerable quantity of amber-coloured fluid. *Heart.*—Base of the organ surrounded with yellow-coloured exudation. Numerous sub-pericardial extravasations especially on the posterior aspect of the left ventricle. *On section.*—Sub-endocardial extravasations in the right ventricle mostly involving the interventricular septum. Sub-endocardial extravasations considerably elevated and especially involving the musculi-papillares. *Liver* large, old signs of perihepatitis, tissue apparently healthy. *Spleen* much enlarged, numerous sub-capsular petechiæ. *Kidneys.*—Numerous small circular extravasations lying on the surface of the organs and dipping into the cortical substance to a distance of $\frac{1}{12}$th of an inch. *Stomach* healthy. *Small and large Intestines* healthy.

Horse No. XXVIII.—Chestnut Country-Bred. Inoculated subcutaneously on 2nd July 1891 at 3 P.M., with 1·5 c.c. of blood taken from the hearts of two rats (*Mus decumanus*) immediately after death. The latent period was twenty-nine days. Considerable swelling and œdema occurred at the seat of inoculation accompanied by conjunctival petechiæ and at a later date by swelling of the right testicle, with fluid in the tunica vaginalis. The hæmatozoon appeared in the blood for the first time on the twenty-ninth day. The temperature during the period of incubation oscillated between 39·6°C. and

35·7°C, a sudden rise taking place on the twenty-second day following the inoculation. At the time of the hæmatozoon being first discovered the temperature was 38°C., but attained a maximum of 38·7°C. on the following morning. Death took place on the evening of the third day of the disease.

Autopsy.—Body fairly well nourished. *Lungs.*—Localized emphysema at the apices and along the free borders of the organs, numerous sub-pleural ecchymoses. No fluid in the pericardial sac. *Heart.*—The base of the organ is surrounded by a light-yellow-coloured exudation, numerous small sub-pericardial extravasations, large masses of almost black-coloured blood lying beneath the endocardial lining of the four cavities, most marked on the right side of the organ; the left auriculo-ventricular valves are also petechiated on their inner surfaces. *Spleen.*—Three times the size of normal, small sub-capsular petechiæ and the superficial vessels of the capsule are injected. *Liver* small, otherwise healthy in appearance. *Kidneys*—numerous cysts filled with green-coloured fluid involving the cortical portion. *Stomach.*—Cuticular portion healthy, villous portion presents several congested patches, one is devoid of the mucous membrane covering it and is surrounded by a zone of congestion. *Small Intestines.*—The internal surface of the mucous membrane is dotted over with dark red coloured petechiæ which are found to lie at considerable distances apart. *Large Intestines* present a healthy appearance. *Nasal fossæ.*—Mucous membrane was considerably thickened and of a dark purple colour, but there was no ulceration. *Brain-membranes* pale, superficial veins deeply congested, the lateral ventricles distended with a clear-coloured fluid, containing a few hæmatozoa.

Horse No. XLII.—Chestnut Country-Bred, aged. Inoculated subcutaneously on the 21st September 1891, at 4 P.M., with 2·0 c.c. of blood, containing numerous hæmatozoa, taken from the heart and great vessels of two rats (*Mus decumanus*) immediately after death. The latent period was thirteen days. Some swelling was present at the seats of inoculation on the day following the injection, but their size remained unaltered up to the 1st October, when the one on the right side of the neck presented a tumour two inches in diameter, and on the evening of the 3rd October it was surrounded by an œdematous zone which disappeared on the appearance of the hæmatozoon in the blood on the following day. Death occurred fifty-two hours after the organism was discovered in the blood of the general circulation. The temperature during the incubative period was normal and subnormal until the day before the disease manifested itself, when it rose at midday to 39·2°C., but fell again the same evening. On the first day of the disease it attained a maximum of 40°C., four hours after the first appearance of the hæmatozoon, and then the temperature gradually fell until the morning on which death occurred.

Autopsy.—Body fairly well nourished, there was a raised swelling at the seat of inoculation about 2½ inches in diameter. On reflexion of the skin a small amount of yellow-coloured exudation was found occupying the subcutaneous tissue. *Lungs.*—Apices the seat of a localized emphysema. *Pericardial* sac contained several ounces of fluid. *Heart.*—Base of the organ surrounded by yellow jelly-like exudation; sub-pericardial extravasations; extensive anteriorly. *On section* sub-endocardial extravasations involving the right auricle, and more especially the right ventricle, but they are absent from the cavities on the left side of the organ. *Liver* small, old signs of perihepatitis. *Spleen* enlarged, sub-capsular petechiæ present. Tissues on section appear healthy. *Kidneys.*—Pale in colour, dotted over with numerous small extravasations, dipping into the cortical portions of the organs. *Stomach.*—Cuticular portion tinged a yellow colour, villous portion, patches of congestion but no ulceration. *Small Intestines* present a number of small sub-peritoneal extravasations; and on section several patches of extravasation lying beneath the mucous coat of the gut. There is no ulceration and there are no parasites.

Horse No. LXII.—Brown Country-Bred pony, aged. Inoculated subcutaneously on the morning of the 14th May 1891, with 2·0 c.c. of blood containing numerous hæmatozoa taken from the heart and large vessels of a rat (*Mus decumanus*) immediately after death. The latent period was sixty-three days. On the day following the injection of blood, a small raised tumour, one inch in diameter, was apparent at the seat of inoculation. On the morning of the third day it had still further increased in size and was tender on manipulation. It continued to increase in extent until the 18th, after remaining stationary in size for a few days, reduction took place on the 24th, and finally disappeared, only leaving a slight thickening of the integument at the site of the tumour. During the whole of this time the blood presented a healthy condition. No symptoms of any kind referable to the disease were observed until the morning of the 16th July 1891, when an urticaria, general in character, broke out, involving the skin of the body, together with the ordinary symptoms of Surra. On microscopical examination the blood was found to be swarming with what appeared to be the ordinary 'Surra' hæmatozoon, and the slightly blood-stained mucus from the inner canthi of the eyelids contained the organism also. The temperature during the latent period oscillated between 39·8°C. and 36°C., but after the appearance of the hæmatozoon it rose rapidly and attained a maximum of 40·6°C. four hours later. The subsequent readings of the thermometer were marked by extreme variations between the evening and morning records. The animal survived the presence of the hæmatozoon by a little over five days.

Autopsy.—Body emaciated, considerable swelling and œdema of the extremities. *Lungs.*—Localized emphysema at the apices and localized infiltration over both bases; consolidation of both bases, individual lobules clearly defined and separated from each other by a layer of yellow exudation. *Pericardial sac* contained two ounces of fluid. *Heart.*—Yellow-coloured exudation round the base dotted over with separate and, in some places, with petechiæ aggregated together. *On section* the endocardial lining in the four cavities was tinged yellow in colour, but there were only a few sub-endocardial extravasations in the left ventricle. *Spleen.*—Enlarged, presented a peculiar lumpy appearance on both surfaces.

Kidneys present a healthy appearance. *Liver.*—Signs of old perihepatitis. *Stomach* presents a healthy appearance. *Small Intestine.* The duodernum and a small portion of the jejunum present an œdematous condition of their walls, but there are no extravasations of blood or signs of ulceration in the whole length of the gut. *Colon* presents a small patch of congestion and there are a number of small worms lying on the mucous membrane, but no ulceration existed.

(*b*). Subcutaneous inoculation with blood derived from positive cases.

Results Positive—Horses Nos. XXXV, XXXVI, XLV, LXVII, XXXVII.

Horse No. XXXV.—Chestnut Country-Bred, aged. Inoculated subcutaneously on the 2nd August 1891, with 0·5 c.c. of blood containing numerous hæmatozoa taken from the jugular vein of Horse No. XXVIII. The latent period was six days. A raised tumour appeared at the seat of inoculation on the day following the injection, which continued tense and tender until the time of the organism appearing in the blood of the general circulation. The temperature remained within the normal limits of health until death which occurred on the second day of the disease.

Autopsy.—Body fairly nourished. *Lungs.*—Consolidation of the anterior portion of both organs, together with sub-pleural extravasations. *Pericardium.*—The sac contained a few ounces of fluid. *Heart.*—Base surrounded by yellow gelatinous exudation, sub-pericardial extravasations. *On section*, the auricles present a few sub-endocardial ecchymoses, whilst there are very extensive sub-endocardial extravasations in the right and left ventricles, especially the former. *Liver.*—Fairly healthy. *Spleen.*—Normal in size, numerous sub-capsular petechiæ. *Kidneys.*—Pale, and cortical vessels congested. *Stomach.*—Villous portion presents a lump due to the 'Spiroptera Megastoma'. *Small Intestines.*—Petechiæ aggregated together in groups, but no ulceration. *Large Intestines.*—Healthy in appearance.

Horse No. XXXVI.—Chestnut Country-Bred, aged. Inoculated subcutaneously on the 2nd August 1891 with 0·5 c.c. of blood containing very numerous hæmatozoa taken from the jugular vein of Horse No. XXVIII. The latent period occupied five days. A raised swelling appeared at the seat of inoculation the day following the injection, which continued to be tense and tender until the appearance of the organism in the blood of the general circulation. The temperature remained sub-normal during the whole time the case lasted, rose on the first day and attained a maximum of 38°C. on the 3rd day of the disease.

Autopsy.—Body fairly nourished. *Lungs.*—The tissue of the apices presented a semi-solid condition and the organs being dotted over with sub-pleural extravasations. *Pericardial* sac contained no fluid. *Heart.*—Numerous and extensive sub-pericardial extravasations. There are a few small sub-endocardial extravasations involving the walls of both ventricles. *Liver*—Signs of old perihepatitis, tissues healthy. *Spleen* enlarged, numerous sub-capsular extravasations. *Kidneys.*—Pale in colour, the stellate veins injected and congestion of the Malphigian corpuscles. Two *Spiroptera Megastoma* tumours involving the villous portion. *Small Intestines.*—Œdematous condition of the walls of duodernum and upper portion of the jejunum, also a few small patches of congestion dotted over the mucous membrane. *Large Intestine.*—Deeply congested patches but no ulceration.

Horse No. XLV.—Brown Country-Bred, aged. Inoculated subcutaneously on the 6th October 1891 with 1·0 c.c. of blood containing swarms of hæmatozoa taken from the jugular vein of Horse No. XLII. The latent period occupied sixteen days. Swelling and œdema followed at the seat of inoculation on the day following, but had entirely disappeared twenty-four hours later. The temperature commenced to rise immediately after inoculation, attaining a maximum of 39·7°C. on the fourth day; from this time until the appearance of the hæmatozoon in the blood it continued to oscillate presenting an intermittent type. For the first five days of the disease the temperature assumed a remittent type with morning remissions and exacerbations in the evening; it then became very irregular and finally death took place on the tenth day of the disease.

Autopsy.—Body fairly nourished. *Lungs.*—The apices were the seat of a localized emphysema; there were also numerous sub-pleural petechiæ. The *pericardium* sac contained a few ounces of blood-stained fluid. *Heart.*—The base of the organ was the seat of a considerable amount of orange-coloured exudation together with extensive sub-pericardial extravasations, especially along the course of the coronary vessels. Small sub-endocardial extravasations in all the cavities with the exception of the right auricle. *Liver.*—Considerably enlarged, signs of old perihepatitis, and on section numerous concretions were found invading the tissues. *Spleen.*—Double the normal size, sub-capsular petechiæ. *Kidneys.*—Normal in appearance. *Stomach*, healthy. *Small Intestines.*—Isolated patches of congestion, no ulceration. *Large Intestine*, healthy. *Parasites.*—A few specimens of Ascaris Megalocephala.

Horse No. LXVII.—Grey Country-Bred, aged. Inoculated subcutaneously on the 21st September 1891, with 1·0 c.c. of blood containing a few hæmatozoa taken from the jugular vein of horse No. LXII. The latent period occupied nine days. Slight swelling and œdema followed at the seat of inoculation on the day after the injection of blood, and remained until the hæmatozoon was discovered in the general circulation. The temperature remained sub-normal until the sixth day after inoculation when it attained 39°C. in the evening, falling to 37·4°C. in the morning, but on the evening of the 7th day it rose to 38·8°C. and became gradually elevated until it attained a maximum of 40°C. on the morning of the second day of the disease. The animal succumbed the same evening.

Autopsy.—Body emaciated, extremities and sheath swollen and œdematous. *Thorax.*—Numerous extravasations lying under the parietal pleuræ on the inner surface of the ribs, but not on the intervening muscular substance. *Trachea.*—Few extravasations on the inner surface lying on the cartilaginous rings. *Lungs.*—*Right* apex, seat of localized emphysema, sub-pleural extravasations over the whole organ, semi-solid patch of tissue at the base. *Left* apex for a distance of two inches dark-red in colour, consolidated, localized emphysema of the anterior portion of the organ, sub-pleural extravasations. *Pericardium.*—This cavity contained six ounces of deeply blood-stained fluid. *Heart* —Reddish-orange-coloured gelatinous exudations surrounded the base of the organ. Large sub-pericardial extravasations, one five inches in length on the external surface of the right ventricle, a second one but small invading the left. *On section*, the right auricle presented a few small sub-endocardial extravasations, exceedingly well marked and numerous in the right ventricle. The left auricle also contained a few, but the left ventricle presented a similar condition to the right, with this exception that the extravasations principally involved the musculi papillares. *Abdominal Cavity.*—The posterior surface of the diaphragm is dotted over with extravasations, as also the small and large intestines. *Spleen* slightly enlarged, dotted over with sub-capsular petechiæ. *Liver* small, signs of old perihepatitis, tissue invaded by calcareous bodies. *Kidneys* pale extravasations on the inner surface of the pelvis, varying in size. *Stomach.*—Cuticular portion was dotted over with yellow flakes; villous portion presented a large patch denuded of its epithelial lining and of a rose colour, and also a raised lump 1·75″ × ·75″ which on section was found to contain a recent dark-coloured blood clot, lying on the muscular coat. *Small Intestines.*—Eight feet from the pylorus, several ulcers were found oval in shape and ¾ inch in length occupying the seats of Peyers patches and in the ileum patches of congestion and near the ileococeal valve several cicatrices. *Large Intestine.*—A few scattered petechiæ. *Parasites.*—One specimen, a female specimen of "strongylus armatus". *Bladder.*—Internal surface the seat of numerous and extensive extravasations, giving to it a dark, almost black, colour. *Brain.*—Superficial veins distended, lateral ventricles large and contained 45 c.c. of fluid.

Horse No. XXXVII.—Chestnut Country-Bred, aged. Inoculated subcutaneously on the 10th August 1891 with 0·7 c.c. of blood, six and half hours *post-mortem* but containing very numerous hæmatozoa previous to death, taken from the jugular vein of horse No. XXXV. The latent period occupied five days. Slight swelling and œdema followed at the seat of inoculation on the day following the injection of blood, and remained until the hæmatozoon was found in the general circulation. The temperature remained sub-normal until the evening before death when it commenced to rise, and at the time of death on the following morning was 38·2°C.

Autopsy.—Body emaciated. *Lungs.*—Apices and free borders were the seat of a localized emphysema, sub-pleural extravasations, early form of pneumonia at the bases of the organs. *Pericardium.*—The cavity contained little or no fluid. *Heart.*—The base of the organ together with the large vessels were the seat of much yellow-coloured exudation. There were numerous sub-pericardial extravasations especially along the course of coronary vessels. *On section*, the right ventricle presented an almost black colour from the general sub-endocardial extravasation; this condition in a modified way existed in the left ventricle, and a few sub-endocardial ecchymoses were observed in the auricles. *Liver.*—Old perihepatitis, otherwise healthy. *Spleen.*—Small, but presented numerous and extensive sub-capsular extravasations. *Kidneys.*—Embedded in yellow-coloured jelly, stellate veins injected. *Stomach.*—The cuticular portion normal in appearance, the villous portion presented several round cupped ulcers, and numerous 'Spiroptera' lying between the rugœ. *Intestines* present a healthy appearance. *Brain.*—Membranes pale, no extravasations on the surface of the convolutions, the cavity of the lateral ventricles contained about three drachms of fluid.

(c) Subcutaneous inoculation with soiled rat's blood.

Result Negative—Horses Nos. LVII, LII, XLIV.

Horse No. LVII.—Brown Country-Bred, entire, aged. Inoculated subcutaneously on the 14th January 1892, with 2·0 c.c. of blood containing numerous hæmatozoa taken from the rat (*Mus decumanus*) immediately after death. A raised tumour appeared at the seat of inoculation, which became tense and hard, but not tender on manipulation. All trace of the swelling at the seat of inoculation disappeared in the course of twenty-six days, but the blood was found healthy on microscopical examination, during the period the animal was under observation. From first to last the animal presented an intermittent type of temperature, which at one time varied as much as 3° C. between the evening and morning readings. The animal presented symptoms of mal-assimilation of food, and was, therefore, destroyed.

Horse No. LII.—Black Country-Bred, pony, aged. Inoculated subcutaneously on the 30th October 1891 with 2·0 c.c. of blood containing numerous hæmatozoa taken from the heart of two rats (*Mus decumanus*) immediately after death. Swelling and œdema followed at the seat of inoculation, and some days later the tumour became tense and hard, and exceedingly tender on manipulation, accompanied by a muco-purulent discharge from both nostrils. As on the 19th November all signs of swelling, &c., had disappeared from the seat of the previous injection, the animal was again inoculated with 2·0 c.c. of blood containing hæmatozoa from a similar source. A slight yellowness of the membranes followed together with a considerable amount of swelling and œdema at the seat of the second injection, but during the whole period which elapsed between the 30th October and January 28th, 1892, no organisms were discovered in the blood. The temperature on the morning of the 7th November registered 37·2° C. but

from this date until the midday of the 9th it steadily rose, attaining a maximum of 39·8° C.; after this it gradually became reduced until on the morning of the 11th it was 36·8°C. and continued oscillating for the next eight days. After the second inoculation on the 19th November, the temperature attained a maximum of 40·1°C. at midday on the 21st, reaching a maximum three days later of 36·2° C. After this date it seldom exceeded the normal limits.

No. XLIV.—Dunn Country-Bred gelding, aged. Inoculated subcutaneously on the 2nd October 1891 with 1·0 c.c. of blood swarming with hæmatozoa taken from the hearts of two rats (*Mus decumanus*) immediately after death. Swelling and œdema followed at the seat of inoculation accompanied with considerable tenderness on manipulation. The blood remained free from hæmatozoon during the whole period during which the animal was under observation. The temperature, which was 35·6° C. at the time of the injection of blood gradually became elevated, attaining a maximum of 39·8° C. at midday on the 12th October, and on the following morning registered only 36·2° C.—a fall of 3·6°C. From this date until death on the 27th November the thermometric readings were very variable, but were marked by morning remissions and exacerbations which attained a maximum sometimes at midday, but more frequently in the evening.

Autopsy.—Body emaciated. *Lungs.*—The anterior portion of each organ was consolidated. *Heart.*—The base of the organ is the seat of cherry-coloured exudation, otherwise there were no pathological changes to note. *Liver* small and healthy. *Spleen*, normal in size, numerous sub-capsular circular patches. *Stomach.*—Spiroptera tumour involving the villous portion, otherwise healthy. *Kidneys* healthy.

(*d*) Subcutaneous inoculation and re-inoculation at a later period with soiled rat's blood with negative results; further inoculation of the same animal with soiled Horse Surra blood. Results Positive.

(*i*).—*Directly into the Jugular vein.*

Horse No. XIII.

XIII.—*Pony* Country-Bred, entire, aged. Directly inoculated into the jugular vein on the 22nd of January 1891, with 0·6 c.c. of blood containing numerous hæmatozoa taken from the heart and vessels of a rat (*Mus decumanus*). As no symptoms supervened the animal was re-inoculated on February 12th with 1·0 c.c. of blood containing numerous hæmatozoa from a similar source as on the first occasion. Swelling and œdema, however, followed at the seats of inoculation, but no organisms were discovered in the blood. After an interval of seventy-six days, the animal was inoculated with 1·0 c.c. of blood from Horse No. XIX in order to prove whether any protection had been acquired through the previous injections of rat's blood.

The temperature after the first inoculation varied between a maximum of 38·5°C. and a minimum of 36·6°C., during the second period between 38·6°C. and 36·1°C., and during the latent period of the horse blood between 38·4°C and 37·4°C. From the first day until the thirty-eighth day of the disease, on which latter day death occurred, continued fever accompanied by remissions and marked intermissions at irregular intervals was present, the hæmatozoon being present in the blood on twenty-eight days.

Autopsy.—Body fairly nourished; considerable œdema of the under-surface of the abdomen. *Lungs.*—The apices were the seat of localized emphysema. The *pericardial* sac contained a few ounces of yellow-coloured fluid. *Heart.*—A few sub-pericardial ecchymoses; cavities free from sub-endocardial extravasations. *Liver.*—Healthy. *Spleen.*—Normal in size, presented a few sub-capsular petechiæ. *Kidneys.*—Healthy. *Stomach*—Cuticular portion yellow in colour; villous portion presents a few congested patches *Intestines.*—Healthy; no parasites.

(*ii*).—*Subcutaneously.*

Horses Nos. XII, XLVIII, XLVI, LVIII.

Horse No. XII.—Country-Bred gelding, aged. Subcutaneously inoculated on the 21st January 1891 with 1·0 c.c. of rat's blood containing numerous hæmatozoa taken from the heart and great vessels of a rat (*Mus decumanus*) immediately after death. Swelling and œdema accompanied by tension and tenderness of the part appeared up to the evening of the fifth day, but disappeared entirely in the course of a few days. As no symptoms of disease had supervened by the 12th February, the animal was re-inoculated with 2·0 c.c. of blood of a rat containing hæmatozoa on that date. On the 5th April, as no hæmatozoa had been discovered in the blood, the animal was inoculated with one drop of blood containing hæmatozoa on the muzzle, taken from Horse No. XIX. During the first period lasting twenty-two days the temperature oscillated between 38·5°C. and 36·8°C., during the second, lasting fifty-two days, between 38·7°C. and 36·6°C. and during the third after inoculation from the horse between 38·6°C. and 38·1°C. The latent period occupied six days. There was continued fever from the first until the evening of the tenth day of the disease, the maximum temperature 40·9°C. being attained on the evening of the sixth day, and it is a point of great interest that although the hæmatozoon was absent during the 8th, 9th and 10th days, the temperature nevertheless remained elevated. On the morning of the 11th, the thermometer registered 2·1°C. lower than on the previous night; the organisms, however, had re-appeared and were noted as few in the blood. Another rise in temperature took place on the twelfth and remained high until the evening before death which took place on the sixteenth day of the disease.

Autopsy.—Body emaciated, extremities swollen and œdematous. *Lungs* the seat of extensive sub-pleural petechiæ and concretions. *The pericardium* sac contained several ounces of saffron-coloured fluid. *Heart.*—Apparently healthy. *Liver.*—Old signs of perihepatitis. *Spleen.*—Enlarged, seat of a few sub-capsular petechiæ. *Kidneys.*—Present a healthy appearance. *Stomach.*—This organ contained a large tumour the work of the *Spiroptera megastoma*. *Intestines* healthy.

Horse No. XLVIII.—White Country-Bred gelding, aged. Inoculated subcutaneously on the 15th October 1891, with 0·75 c.c. of blood containing numerous hæmatozoa taken from the heart of a rat (*Mus decumanus*) immediately after death. Swelling and œdema together with tension and tenderness of the part followed at the seat of inoculation, but no hæmatozoa appeared in the blood up to the 30th, consequently re-inoculation with 1·0 c.c. of blood containing numerous organisms from similar source was performed on that date. The same local symptoms followed as on the previous occasion, but again the blood remained healthy.

On November 12th, it was decided to inoculate with Horse Surra in order to observe whether any modification of the disease would be produced in consequence of the previous injections of rat's blood. The animal was, therefore, inoculated with ·5 c.c. of blood which was free from the hæmatozoon, having been taken from Horse No. L during an intermission. From the 15th to the evening of the 29th of October the temperature maintained a certain degree of constancy varying between 38·4°C. and 37°C. but on the morning of the 21st touched 36·2°C. During the second period between the 30th October and the 11th of November the temperature attained a slightly higher limit, *viz.*, between 38·8°C. and 36·8°C. And during the third period, the incubative period of the Horse Surra, 40°C. was reached, the minimum range being 35·6°C. The latent period occupied ten days. The animal succumbed on the second day of the disease.

Horse No. XLVI.—Black Country-Bred, entire, aged. Inoculated subcutaneously on the 15th October 1891, at 5 P.M., with 2·0 c.c. of blood containing numerous hæmatozoa taken from the hearts of two rats (*Mus decumanus*) immediately after death. Marked swelling and œdema together with tension and tenderness of the part on manipulation followed at the seat of injection. The œdema disappeared on the 23rd instant, leaving a hard raised tumour, which lasted on for a week or ten days longer. As no symptoms of disease supervened it was decided to inoculate the animal with Horse Surra blood. Consequently, on the 23rd of November, 1·0 c.c. of blood drawn from the heart of Horse No. LXVIII, one hour and a quarter *post mortem*, was used. Swelling and œdema followed at the seat of the second injection of blood four days later accompanied by the usual symptoms. After an incubative period lasting eight days the hæmatozoon made its appearance in the blood of the general circulation. From the 15th October to the 22nd November the temperature presented an almost intermittent type, there being, in most instances, a considerable difference between the morning and evening record, but it only on four or five occasions exceeded the normal limits. Between the 23rd November and the appearance of the organism on the 1st December, the thermometric readings varied between 35·6°C. and 38·5°C., but on the second day of the disease attained a maximum of 40·1°C., and then gradually fell to 36·8°C. in twenty-four hours, finally oscillating until death which took place on the 7th December, the seventh day of the disease.

Autopsy.—Body emaciated, visible mucous membranes are yellow in colour, considerable œdema of the extremities and exudation under the belly. *Lungs* presented a yellowish red colour together with sub-pleural petechiæ. *Heart.*—The base of the organ is surrounded by yellow-coloured exudation. Large and extensive sub-pericardial extravasations as well as numerous small petechiæ were found on the right ventricle and running down with the anterior coronary vessels. There were sub-endocardial extravasations in all the cavities with the exception of the left auricle. Those in the ventricles were the most extensive, especially in the left. *Liver.*—Enlarged, tissues tinged a yellow colour. *Spleen.*—Enlarged to two and a half times the normal size; numerous sub-capsular petechiæ. *Kidneys* tinged yellow.

Horse No. LVIII.—Country-Bred horse, aged. Subcutaneously inoculated on the 18th February 1892 with 2·0 c.c. of blood containing very numerous hæmatozoa taken from several rats (*Mus decumanus*) immediately after death. Considerable swelling and œdema appeared at the seat of inoculation, accompanied by tension and tenderness of the part. On the 9th March the swelling had all disappeared. On the 29th of the same month, no symptoms having supervened, the animal was inoculated with 1·0 c.c. of blood taken from the heart of Horse No. XLVII five and a half hours after death. The blood contained swarms of hæmatozoa *ante mortem*. Swelling and œdema with the accompanying tension and tenderness of the parts intervened, but the latter disappeared at the advent of the organism in the general circulation after a latent period lasting nine days. On the morning of the second day of the disease an urticaria appeared on the head and neck which later became general in character but commenced to fade towards evening and had entirely disappeared on the following morning.

The temperature was marked, during the period which elapsed between the 18th February and 29th March, by daily remissions and exacerbations which, on several occasions, varied over 3°C. between the maximum and minimum. From the appearance of the hæmatozoon until death which took place on the 3rd May, the twenty-seventh day of the disease, a continued fever accompanied by remissions and at irregular intervals by well marked intermissions was present.

Autopsy.—Body somewhat emaciated. Swelling and œdema of the extremities and under-surface of the abdomen. *Lungs.*—Localized emphysema at the apices, extensive sub-pleural ecchymoses. Fluid in the *pericardium*. *Heart*, sub-pericardial extravasations. No endocardial complication. *Liver.*—Old perihepatitis. *Stomach.*—No pathological changes; numerous spiroptera. *Spleen.*—Enlarged, sub-

capsular petechiæ. *Kidneys* petechiated. *Small Intestines.*—Mucous membrane petechiated, no ulcerations. *Large Intestines* healthy.

(*e*) Subcutaneous inoculation of animals other than horses with soiled rat's blood.

(*i*) *Results Positive*—Bull No. IV, Monkey No. II, Field Rats Nos. I and II.

Bull No. IV—was inoculated on July 27th, 1892, with 2·0 c.c. of blood containing the hæmatozoon taken from the rat (*Mus decumanus*) immediately after death. A considerable amount of swelling and œdema followed at the seat of the injection, which gradually decreased in extent and finally disappeared about the 10th August 1892. From the 27th July until October 10th, 1892, the blood remained free from the hæmatozoon. On the evening of the 9th September an urticaria broke out on both sides of the neck, chest and scapular regions, but had disappeared entirely by the following morning. On the morning of the 3rd October 1892, a similar eruption to the former made its appearance and again faded the same day. On microscopical examination of the blood on the 11th October, the 76th day after inoculation, a long and active '*Trypanosoma*' was discovered, the dorsal membrane being particularly well developed. From that date up to the 9th February 1893, the 121st day of the disease, although the blood was subjected to careful examination daily, no further hæmatozoa were observed.

The *temperature* on the morning of the 8th day following inoculation attained a maximum of 41°C., but by the following morning had fallen 2°C., and although it subsequently on numerous occasions touched 40°C. it has only once risen to 40·3°C. From November 16th the pyrexia was characterized by marked morning remissions and evening exacerbations especially on the 55th, 56th, and 59th days of the disease when the morning and evening temperatures varied from 2·5°C. to 3·°C. (4·5° to 5·4°F.). The animal lost flesh during the months of August, September, October and November, but at the present time (January 1893) is beginning to put on flesh.

Two Guinea Pigs inoculated on the 21st September 1892 with blood from this animal, in which no hæmatozoa could be discovered, failed to contract the disease.

As it was now February 9th, 1893, 197 days since the animal was subjected to the injection of rat (*Mus decumanus*) blood and 121 days since the last appearance of the hæmatozoon in the blood, it was decided to inoculate with Horse Surra blood in order to test whether any protection had been acquired from the previous inoculation. Consequently, the animal was subcutaneously inoculated at 5-30 P.M. with 2·0 c.c. of blood containing numerous hæmatozoa, drawn from the jugular vein of Horse LXXXIV immediately after death. No swelling followed this operation, but on February 14th, 1893, the muzzle became hot and dry, and there was considerable fever lasting several days, but the hæmatozoon was not discovered although the blood of the animal was collected and examined microscopically three times daily during the period the fever lasted. On the 30th of April, 80 days after the re-inoculation, the hæmatozoon was observed in small numbers and remained in the blood for 48 hours, after which it disappeared and was absent until the 18th July 1893, a period of 78 days, when it was again present in small numbers for one day. From this date until the 29th January 1894, a period of 195 days, when the animal was killed in consequence of having met with an accident, the hæmatozoon was never found although daily examinations of blood were made.

Probably hæmatozoon was present in the blood in small numbers during the presence of the fever.—February 14th, 1893.

Monkey No. II.—(*Macacus Rhesus*) was subcutaneously inoculated in the right inguinal region on 23rd March 1893 with 1·50 c.c. of blood containing numerous hæmatozoa taken from the heart of a rat (*Mus decumanus*) immediately after death. A slight thickening followed the injection at the seat of inoculation. The latent period occupied three days. The organisms appeared in the blood in small numbers for one day only, although the microscopical examination of that fluid was continued daily until 23rd July 1893, a period of 120 days. The temperature during the days of observation varied between 38·2° and 39·3°C., after inoculation it oscillated between a maximum of 41·0° and a minimum of 37°C.

Field rats (*Nesokia providens*) inoculated with blood *from the rat* (*Mus decumanus*). Two field rats were subcutaneously inoculated on the 13th February 1891, each with blood containing numerous hæmatozoa taken from the hearts of two rats (*Mus decumanus*) immediately after death.

No. I received 0·6 c.c. subcutaneously. The latent period occupied seven days. The hæmatozoon was present in the blood off and on until May 26th, 1891, on which day it succumbed, 102 days after inoculation.

Autopsy.—Spleen large, otherwise the organs appeared healthy.

No. II received 0·4 c.c. The latent period occupied as in the case of No. I seven days. The hæmatozoon was present off and on until 31st July 1891, on which date death took place, 168 days after inoculation.

Autopsy.—The spleen was enlarged, otherwise the organs presented a healthy appearance.

(*ii*) *Results Negative.* Donkey No. III, Monkey No. I, Cat No. II, Rabbits Nos. I, II, III, IV, Guinea Pigs Nos. I, II, III, Fowls Nos. I, II.

Donkey No. III.—This animal was in fair condition, but aged. It was kept under observation and the blood examined daily from 28th January until 9th March 1893, on which latter date it was sub-

cutaneously inoculated with 1·0 c.c. of blood, containing very numerous hæmatozoa, taken from the rat (*Mus decumanus*) immediately after death. A swelling, tense and tender on manipulation, was noticed at the seat of inoculation, which gradually subsided in the course of ten days. During the period of observation, the temperature varied between a maximum of 39·8° and a minimum of 35·4°C. From the time of inoculation until death, which occurred on the 5th May 1893, the temperatures varied between 39·4° and 35°C.; and during the last twenty days of life it became of a markedly intermittent type, the morning and evening registration showing a difference of from 3 to 3·5 degrees Centigrade (5·4 to 6·3°F.).

Although the blood of this animal was submitted twice daily to microscopical examination, the hæmatozoon was never discovered, moreover, no symptom in any way pointing to the existence of such a disease became manifest during the course of the case.

Two Guinea Pigs, however, were each inoculated with 0·5 c. c. of blood, taken from the heart of the donkey, at 11-30 A.M. on the 5th May 1893, three hours and 45 minutes after death, in which no organisms could be found.

No. (i) *Guinea Pig.*—The hæmatozoon appeared in the blood on the 9th June 1893, after a period of incubation lasting 35 days. Death followed on the 20th June, 46 days from the day of inoculation and 11 days after the first appearance of the hæmatozoon in the blood.

No. (ii) *Guinea Pig.*—The result was negative.

Two Guinea Pigs Nos. (iii) and (iv) were subcutaneously inoculated with blood taken from No. (i), immediately after death. The hæmatozoa were swarming just before the animal succumbed.

No. (iii) *Guinea Pig* received 0·2 c.c. of blood, taken from the heart of Guinea Pig No. (i), immediately after death. Latent period occupied four days. Paroxysm lasted six days, on the last day of which the animal succumbed.

No. (iv) *Guinea Pig* received 0·2 c.c. of blood taken from the heart of Guinea Pig No. (i), immediately after death. Latent period occupied a very few hours, for, the inoculation was performed at 12-30 P.M. on the 20th June 1893, and at 10 A.M. on the 21st June, when the microscopical examination of the blood was made, hæmatozoa were found to be then present and continued for following eleven days, on seven of which the organisms were swarming. From the first appearance of the organism in the blood until death supervened, 82 days elapsed; this period was made up of 4 paroxysms lasting 78 days and 4 intermissions lasting $4\frac{1}{2}$ days.

Autopsy.—Body somewhat emaciated, no œdema. *Thorax.*—Pleural cavities free from fluid. *Lungs.*—Emphysematous, sub-pleural extravasations. *Heart* healthy. *Liver* enlarged, very dark in colour. *On section*, tissues contain fair quantity of dark-coloured blood. *Spleen.*—Slightly enlarged, tissues firm. *Kidneys.*—Both organs petechiated, right organ to a greater extent than the left. *On section*—Tissues pale. *Bladder* presents healthy appearance.

Monkey No. I (*Macacus radiatus*)—was subcutaneously inoculated on the 1st August 1891 with 0·5 c.c. of blood containing numerous hæmatozoa, taken from the heart of a rat (*Mus decumanus*) immediately after death. A slight thickening followed the injection of blood at the seat of inoculation. The *temperature* on the evening of the 8th and morning of the 9th August reached 39·8° and 40°C. respectively; but from the latter date until the morning of the 26th when it rose to 40·3°C., the temperature remained normal. As no symptoms of Surra had developed, on the 2nd September the animal was re-inoculated with 0·5 c.c. of blood from a similar source. On the evening of the 14th of September the temperature rose from 38·8° to 41·1°C. regaining the normal on the morning of the 16th. Similar elevations took place on the 17th, 21st, and 25th. On the latter date the animal appeared to be ill, but the condition of the blood was unchanged. Two days later the breathing became quickened and a dull and sleepy condition supervened, from which the animal never rallied.

Autopsy.—Body well nourished *Lungs.*—There were a number of small purple-coloured sub-pleural petechiæ dotted over the surface of the organs. The right inferior lobe was covered with a layer of yellow lymph $\frac{1}{12}$th inch in thickness. *On section.*—The tissue of both the lungs presented a healthy appearance. *Pericardium* was distended with clear coloured fluid; no pericarditis. *Heart.*—Healthy. *Liver*, *Spleen*, *Kidneys*, and *Bladder* healthy.

Cat No. II (*Felis domesticus*).—This animal, large, full grown, yellow in colour and very wild, was inoculated at 5 P.M. on the 14th January 1893, with 0·5 c. c. of blood containing numerous hæmatozoa, taken from the heart and large vessels of a rat (*Mus decumanus*) immediately after death. The temperature during the period of observation averaged 38·4°C., after inoculation and for a period of 184 days during which it was taken three times daily it oscillated between a maximum of 40·8° and a minimum of 36·6°C.

The blood was also daily submitted to miscroscopical examination from 14th January to 16th July 1893, but no organisms were discovered. Result negative.

Rabbits inoculated with Rat's (*Mus decumanus*) *blood.*

No. I was inoculated subcutaneously on the 7th December 1890, with 0·5 c.c. of blood, containing numerous hæmatozoa taken from the heart of a rat (*Mus decumanus*) immediately after death. On the following morning the temperature rose to 40·7°C., but no hæmatozoa appeared in the blood and the animal was still living and in good health six months later. Result negative.

No. II was inoculated subcutaneously on the 7th December 1890, with 0·2 c.c. of blood from a similar source to No. I. No symptom of any kind was noticed until 8th March 1891, when the animal presented a muco-purulent discharge running from both nostrils, and the eyelids glued together caused by the drying of the purulent secretion coming from them. Several peculiar-shaped bodies were observed in the blood on the 12th April, but the hæmatozoon was never discovered in it. The animal eventually regained its normal health. Result negative.

Two rabbits Nos. III and IV were inoculated in the tunicæ vaginales testes on the 23rd July 1892, with 0·5 c.c. of blood containing numerous hæmatozoa taken from the hearts of two rats (*Mus decumanus*) immediately after death.

No. III died two days later of general peritonitis, but no hæmatozoa were discovered in the blood or peritoneal fluid.

No. IV.—Three days after inoculation, the scrotal sac became red, swollen and the surface temperature raised, and on the 16th day following the injection of blood, suppuration ensued and a caseous mass escaped. The wound healed, and the animal appeared to have regained its normal health, but succumbed on the 4th September, 42 days after inoculation. The hæmatozoon was not discovered in the blood. Result negative.

Guinea Pigs inoculated with the blood of the Rat (Mus decumanus).

Two Guinea Pigs Nos. I and II were inoculated subcutaneously on the 22nd November 1891, with 0·5 c.c. of blood containing numerous hæmatozoa taken from the hearts of two rats (*Mus decumanus*) immediately after death. In both cases their blood was examined up to March 9th, 1892, but with negative results.

Guinea Pig No. III was subcutaneously inoculated with the same quantity of blood from a like source on 19th September 1892, and as by the 30th October, no symptoms of Surra had supervened, it was re-inoculated with 0·2 c.c. of blood in each inguinal region. Enlarged glands followed in the neighbourhood of the seats of the injection of blood. But no hæmatozoa were discovered on microscopical examination. Death, however, took place on the morning of the 12th November 1892.

Fowls inoculated with Rat's (Mus decumanus) blood.

Two fowls (*Gallus domesticus*) were each inoculated subcutaneously on the 23th January 1891, with 0·3 c.c. of blood containing numerous hæmatozoa taken from the heart of a rat immediately after death. As up to June 12th, no symptoms referable to the inoculation had supervened, the birds were re-inoculated with blood swarming with hæmatozoa, taken from the jugular vein of Horse No. XIII *post mortem*, just previous to death. The blood in each case was daily submitted to microscopical examinations, but with negative results.

(*f*) Subcutaneous inoculation with the soiled blood of different animals, which had been previously inoculated from the rat.

(*i*) *Result Positive*—Bull No. III, Donkey No. II, Cow No. I, Cat No. I, Dog No. I, Horse No. LXIX, Rabbit No. II.

Bull No. III.—Age 4 years. This animal was subcutaneously inoculated, on the 31st July 1892, with 1·0 c.c. of blood containing very numerous hæmatozoa, taken from the jugular vein of Horse No. LXVII, but previously from the rat (*Mus decumanus*). The latent period occupied three days. The hæmatozoon was present in the blood from the 3rd to the 9th August inclusive. After an interval of thirteen days, it was again present in small numbers for two days, August 23rd and 24th. After a second interval of nine days it re-appeared for one day, on the 3rd September. During a further period of 158 days, accompanied by daily microscopical examinations of the blood, no organisms were observed. The temperature became rapidly elevated after inoculation and attained a maximum of 41·4°C. on the fourth day of the disease, and then gradually fell until the morning of the 8th day, when it registered 38·8°C. It again rose to 41°C. on the 37th day. The pyrexia, since November 14th, has been characterised by morning remissions and evening exacerbations, especially on the 143rd, 155th, 156th, 168th, 178th days of the disease. During the months of August and September this animal became greatly emaciated, but by December had put on a considerable amount of flesh and appeared quite healthy.

Two Guinea Pigs, inoculated on the 21st September 1892, with 0·3 c.c. of blood, in which no hæmatozoa could be discovered, after a latent period of 14 days, contracted Surra.

As 191 days had elapsed since the animal was subjected to the injection of Rat Surra (through horse) blood, and 158 since the last appearance of the hæmatozoon in the blood, on the 3rd September 1892 it was decided to re-inoculate with Horse Surra blood, in order to test whether any protection had been acquired from the previous inoculation. Consequently, the animal was subcutaneously inoculated at 5-30 P.M. on the 9th February 1893, with 2·0 c.c. of blood containing numerous hæmatozoa, just before death, but drawn from the jugular vein of Horse LXXXIV immediately death occurred. No swelling or œdema followed, but on the 4th day there was a slight thickening of the tissues at the seat of inoculation. Three paroxysms occurred, lasting 1, 3 and 3 days, with three

intermissions of 109, 9 and 58 days, respectively. The animal contracted rinderpest on the 26th September 1893, and death took place on the 28th.

Donkey No. II.—This animal was subcutaneously inoculated on the 31st July 1892, with 1·0 c.c. of blood, containing very numerous hæmatozoa, taken from the jugular vein of Horse No. LXVII. This horse had been inoculated from Horse No. LXII, which had been injected with blood directly from the rat (*Mus decumanus*). The *latent* period occupied four days. The animal lived 144 days, after the appearance of the organism in the blood, during which period twenty-one paroxysms and twenty intermissions occurred. The longest time during which a *paroxysm* lasted was seven days, the shortest one day; *intermission* ten days, the shortest one day, giving an average length of nearly 3·3 days for the former and 3·75 days for the latter. The *temperature* during the first 27 days of the disease varied between 41·4°C. and 39·2°C., but on the 28th day fell to 38°C. From this latter date until the 120th day of the disease, periodical attacks of fever occurred lasting five to six days, the temperature rising from normal to 41°C. or over, and again falling to 38°C. or thereabouts. The third stage was marked between the 120th and 144th days, on which latter date death took place by well marked remissions in the morning and exacerbations in the evening, which towards the close of the case became exaggerated, especially on the 12th, 13th, 14th, and 24th December, when the temperature varied as much as from 3°C. to 4·4°C. (5·4° to 7·9°F.). The hæmatozoa were present during this period for sixty-nine out of one hundred and forty-four days.

Autopsy.—Body emaciated. No swelling or œdema about the extremities or under-surface of the abdomen. *Thorax.*—No fluid in the pleural cavities, and no adhesions of the pleuræ. *Lungs.*—Small, localized emphysema of the apices and inferior borders of both organs; a few lobules presented an atalectatic condition; tissues fairly healthy. *Pericardium.*—The sac contained half an ounce of a clear, amber-coloured fluid. *Heart.*—The base of the organ was surrounded by light yellow exudation, which also surrounded the origin of the great vessels, and was dotted over by a few purple-coloured petechiæ. All the cavities presented a healthy appearance with the exception of the left ventricle which contained a few sub-endocardial extravasations. *Liver.*—Healthy. *Spleen.*—Normal in size, a few sub-capsular petechiæ; tissues healthy in appearance. *Stomach* contained no food, but one ounce of a yellow-coloured fluid. *Cuticular* portion was healthy in appearance. *Villous* portion presented a strip, three inches wide from the line of limitation, of a bright rose colour, but there was no solution of continuity. A tumour 2·5″ × 1·5″ × 1″ occupied the fundus of the organ, and *on section* numerous *Spiroptera megastoma* were presented to view. Dotted over the mucous membrane were also 24 circular raised plaques with a thickened, pale-looking edge around the circumference of each; some are cupped on the surface, whilst others have lost their epithelial covering. *Small intestines* present a few small petechiæ scattered over the surface of the mucous membrane. At the commencement of the jejunum, a small circular and somewhat raised tumour was found, which *on section* presented a small cavity in its interior, $\frac{1}{8}$ inch in diameter, and filled with healthy-looking pus. *Cæcum* healthy, but numerous small "Strongyli." *Colon* presented several patches of congestion dotted over the walls, but no solution of continuity. Two Guinea Pigs were injected subcutaneously with 2·0 c.c. of urine on the 8th August 1892, with negative results.

Cow No. I.—This animal was obtained on 24th August 1892, with a calf at her side three weeks old. She was giving 2 to 3 seers of milk a day. The experiment determined upon had for its object the following, viz:—(i) when Surra is communicated to a cow in milk, does the hæmatozoon or its immature form pass from the general circulation into the milk? (ii) will a calf suckling its mother under such conditions contract the disease? The animal was inoculated subcutaneously on the 28th August 1892 with 1·0 c.c. of blood containing very numerous hæmatozoa drawn from the jugular vein of Donkey No. II. The period of incubation occupied five days. No swelling or œdema was observed at the seat of inoculation, although a slight thickening could be felt in the subcutaneous tissue. Four paroxysms lasting 5, 1, 1 and 2 days, respectively, were followed by three intermissions lasting 55, 18 and 21 days, respectively. The milk from the first day of the appearance of the *Trypanosoma* in the blood was daily submitted to a searching *microscopical* examination, but on no occasion was a single hæmatozoon discovered. On the 9th February 1893, as 58 days had intervened since the Surra hæmatozoon had been last observed in the blood, and as the animal appeared to be in good health, it was decided to re-inoculate it, with a view to determine whether any protection had been conferred by the first attack. Consequently, at 6 P.M., on the last-named date, the animal was subcutaneously inoculated with 2·0 c.c. of blood containing numerous hæmatozoa taken from the jugular vein of Horse No. LXXXIV immediately after death. The latent period occupied 8·5 days and no local manifestation was observed at the seat of the injection. From the first appearance of the organism in the blood on the 18th February 1893 until 31st May 1894, six paroxysms each lasting from 1 to 2 days occurred. The hæmatozoon never exceeded two in a field of the microscope (Zeiss.Oc. 3, Obj D). The length of the intermissions was 10, 29, 70, 9, 128 days, respectively, but as the examination of the blood was only discontinued on May 31st, 1894, 214 days after the last appearance of the organism in the blood, it is very unlikely that the hæmatozoon would have again appeared in the circulation. On this latter date the animal was in good health, and in very fair condition.

Two Guinea Pigs were inoculated subcutaneously with 0·5 c.c. of blood each, containing a few hæmatozoa, taken from the ear of the cow during paroxysm V of the second inoculation period.

Guinea Pig No. I.—The period of incubation occupied five days. The organisms were present for five days in the circulation, on the last of which the animal succumbed. Temperature varied between 35° and 40°C.

Guinea Pig No. II.—Period of incubation five days. Death on the 3rd day of the first paroxysm. Temperature varied between 38·6°C. and 40·6°C. This appears to have been a very severe type of Surra.

Guinea Pig No. III.—Inoculated with 0·4 c.c. of blood containing a few hæmatozoa taken from the ear of the cow on the 28th October 1893. The period of incubation occupied five days. The animal lived 71 days after the first appearance of the organism in the blood. Two paroxysms occurred lasting 68 days, and one intermission 3 days. The organisms were very sluggish on the day of death.

Guinea Pig No. IV—Was subcutaneously inoculated on 12th January 1894, with 0·3 c.c. of blood taken from the heart of Guinea Pig No. III, 21 hours *post mortem*. The latent period occupied ten days. The animal only lived 20 days after the first appearance of the organism in the blood. This period was made up of three paroxysms lasting 13 days and two intermissions lasting 2 days. Organisms were very sluggish on the day of death.

Guinea Pig No. V.—This animal was inoculated on the 11th February 1894, with 0·4 c.c. of blood taken from the heart of Guinea Pig No. IV, 12 hours *post mortem*. No organisms were discovered in the inoculated blood. The blood of this animal was examined microscopically until the end of March, but no Surra organisms made their appearance in it. *Result negative.*

Cat No. I.—A young animal about three months old was subcutaneously inoculated on the 28th August 1892 with 0·5 c.c. of blood containing very numerous hæmatozoa, taken from the donkey, but originally derived from the rat (*Mus decumanus*). The latent period occupied five days, after which the hæmatozoa were found to be swarming in the blood. For the first ten days of the disease the temperature oscillated between 38·4° and 40·4°C., but from the latter date until death, which took place on the fiftieth day of the disease, there was continued fever, and for the greater part of the time a temperature which oscillated between 39·7°C. and 41·4°C. The hæmatozoon was present on forty-five out of fifty days, and for the last twenty-four was never absent. A symptom of considerable interest presented itself in this case towards its termination, *viz.* the appearance of localized œdematous swellings of an erratic nature present in one part of the body one day and in another part on the following day.

Autopsy.—Body somewhat emaciated. The extremities are not swollen or œdematous, although there is some present in front of the chest and on the under-surface of the abdomen. There are several dark red coloured glands undergoing caseation in the inguinal regions. *Thorax.*—No fluid in the pleural cavities and no pleuritic adhesions. *Lungs.*—Localized emphysema especially at the apices. The *pericardial* sac contains a small quantity of light amber-coloured fluid. *Heart* presents a healthy appearance. *Abdominal Cavity.*—There is no fluid in the peritoneal cavity, but there are several enlarged glands lying on either side of the lumbar vertebræ. *Stomach* presented healthy appearance. *Spleen* presented a healthy appearance. *Liver* presented a healthy appearance. *Kidneys* presented a healthy appearance. *Intestines* presented a healthy appearance. *Bladder* presented a healthy appearance. *Urine* in the bladder contained $\frac{1}{4}$ albumen.

Dog No. I.—This animal, a little more than three months old, was inoculated, on 28th August 1892, with 0·6 c.c. of blood containing very numerous hæmatozoa, taken from the jugular vein of the donkey, previously passed from the rat (*Mus decumanus*) through the horse to the donkey. The latent period occupied five days. Continued fever was present from the time of inoculation until death took place, with the exception of two slight intermissions which occurred on September 3rd and 25th. The temperature varied from 38·2°C. to 40·4°C. The hæmatozoon was present for twenty-two days out of the twenty-five the disease lasted, cerebral symptoms supervened together with $\frac{1}{16}$ albumen in the urine, and death took place twelve hours later.

Autopsy.—Body well nourished. The right cornea was almost opaque. Two enlarged inguinal glands. *Thorax.*—No fluid in the pleural cavities. *Lungs.*—Localized emphysema at the apices, also numerous sub-pleural extravasations. *On section*, the tissues presented mottled appearance and frothy mucus exuded on pressure. The *pericardial* sac contained one ounce of straw coloured fluid and a few shreds of lymph were attached to the muscular structure of the heart anteriorly. *Heart.*—The external surface was free from sub-pericardial extravasations as also the cavities of the auricles and ventricles on section. *Abdominal cavity.*—This cavity is free from fluid. *Stomach* presents a healthy appearance. *Liver* presents a healthy appearance. *Spleen* was dotted over with dark-coloured sub-capsular petechiæ. *On section*, tissues soft and dark in colour. *Kidneys* pale and dotted over with numerous small purple-coloured petechiæ. *Intestines* present a healthy appearance. *Brain.*—Membranes pale, superficial veins contain little blood. The surface of the hemispheres presented a healthy appearance and there was no fluid in the lateral ventricles. *Eyes.*—Right cornea more or less opaque, the left was slightly fogged.

Horse No. LXIX.—Australian mare, aged. Inoculated subcutaneously, on the 3rd September 1892, with 0·5 c.c. of blood swarming with hæmatozoa taken from the cow. The latent period occupied five days, a small circular and raised tumour appeared at the seat of inoculation on the day following the injection and continued to increase for four days and then remained stationary; during this time there was tenderness on manipulation and marked tension of the part. On the morning of the sixth day the tension and tenderness had decreased and a few hæmatozoa were discovered in the blood of the general circulation. During the incubation period the temperature gradually rose and was marked by well marked morning remissions and evening exacerbations. On the first day of the disease at the

time of the discovery of the organism in the blood, the temperature registered 37·4°C., but at midday had attained a much higher degree, 39·8°C., and a maximum of 41·2°C. was reached on the evening of the second day of the disease. The fever was of the continued type accompanied by frequent remissions and exacerbations and intermissions at irregular intervals. Death occurred on the fourteenth day of the disease.

Autopsy.—Body very slightly emaciated, the extremities were swollen and œdematous. *Lungs.*—The apices were the seat of localized emphysema. *Pericardium.*—The cavity contained about one pint of dark blood-stained fluid. *Heart.*—The base is encompassed by yellow-coloured exudation and dotted over with sub-pericardial petechiæ. *On section.*—No sub-endocardial extravasations in the right or left auricles or right ventricle, but there were well marked ones in the left ventricle. *Liver* enlarged, fairly healthy. *Spleen.*—Three times the normal size, numerous sub-capsular petechiæ. *Kidneys* petechiated. *Stomach.*—*Cuticular* portion stained yellow. *Villous* portion healthy. *Small Intestines.*—Limited area petechiated, no ulceration. *Large Intestines* healthy. *Rectum* presents a patch which is partially denuded of the superficial portion of the mucous membrane. *Parasites* none.

Rabbit No. II.—This animal was subjected to inoculation on the 21st July 1892, with 0·75 c.c. of blood, containing numerous hæmatozoa, drawn from the heart of Horse No LXII, fifteen minutes *post mortem*. This horse was inoculated with rat's (*Mus decumanus*) blood. The latent period occupied five days. The temperature rose to 41·2°C. on the morning of the first appearance of the hæmatozoon, and the same evening registered 41·7°C. (107°F.). The animal succumbed on the morning of the 12th August.

(*ii*).—*Results Negative.*—Bull No. I, Rabbit No. I.

Bull No. I.—Deccani-bred. This animal was kept under observation for some time, during which it appeared quite healthy. It was subcutaneously inoculated on 24th March 1891 with 1·75 c.c. of blood, containing numerous Surra hæmatozoa, taken from the jugular vein of Horse No. XIX. A considerable amount of swelling and œdema, with tenderness on manipulation followed at the seat of inoculation. On the evening of the 28th May, the temperature rose to 39·7°C., and on the following morning one hæmatozoon was discovered on microscopical examination after searching through several specimens of blood. On the 30th no hæmatozoa were found in the blood, but on the 31st and 1st April a few were observed; from this date until the 17th June, no more hæmatozoa or their immature forms were seen although carefully searched for. On June 17th, eighty-five days after the inoculation of the animal, two Guinea Pigs were inoculated subcutaneously with 0·2 c.c. of blood from the Bull. No. I Guinea Pig developed hæmatozoon in the blood on the 27th, ten days after inoculation, while No. II Guinea Pig did not develop any until the 5th July, or eighteen days after inoculation. The organisms were present off and on in the blood of these animals for a considerable period. No. I finally succumbing to the disease on the 8th of November 1891 or 144 days after its inoculation, whilst No. II died on the 12th October 1891, or 117 days after inoculation. During the interval which elapsed between the 17th June and 3rd September 1891, no hæmatozoa were discovered in the blood of the bull, although several cover-glass specimens of it were examined every day. Consequently two more Guinea Pigs were inoculated. Nos. III and IV each received 0·2 c.c. of blood from the bull on the 163rd day after its inoculation. These animals both developed hæmatozoa on the 10th day and the organisms remained almost constantly present in their blood until the day of their death, 24th October and 14th December respectively. On the 13th November 1891, that is, 234 days after the inoculation of the bull, two Guinea Pigs Nos. V and VI were inoculated with 0·2 c.c. of blood from that animal, but as no hæmatozoa were found during the next 32 days, they were re-inoculated on the 16th December 1891, 267 days after the inoculation of the bull, but with negative results a second time. Between the latter date, 16th December 1891 and 14th March 1892, the bull appeared to be enjoying good health and putting on flesh. On this latter date, that is, 356 days from the time of inoculation, two new Guinea Pigs No. VII and VIII were inoculated as previously with 0·2 c.c. of blood from the bull, but this experiment was also followed by negative results. Since 24th March, the bull has been in very fine condition, and as it is desirable to ascertain whether animals of the bovine species are liable to a second attack of Surra, it was resolved to re-inoculate this animal with a more virulent type of Surra, obtained by passing the hæmatozoon of the rat (*Mus decumanus*) through the horse and donkey. This second inoculation was performed on the 22nd August 1892, when 1·0 c.c. of blood drawn from the jugular vein of the donkey, was subcutaneously injected over the left scapular region, the blood at the time containing very numerous and active hæmatozoa. No swelling or œdema followed, only slight subcutaneous thickening in the tract of the injection needle. On the 28th of the same month a peculiar organism was found in the blood, but on that day only. The animal put on flesh, and appeared in robust health. On the 21st September 1892 two Guinea Pigs were inoculated with blood drawn from the jugular vein, but up to the 14th November 1892, their blood, which had been examined daily, failed to show any signs of the Surra hæmatozoon. The blood of Bull No. I was submitted to microscopical examination until the 22nd July 1893, a period of 345 days after the date of the second inoculation; no Surra hæmatozoa were discovered, but only one giant form of *Trypanosoma* on 27th August 1892.

Rabbit No. I was subjected to inoculation on the 21st July 1892, with 0·75 c.c. of blood containing numerous hæmatozoa, drawn from the heart of Horse No. LXII, fifteen minutes *post mortem*. This horse was inoculated with rat's (*Mus decumanus*) blood. It succumbed on the morning of August 1st, 1892, but no hæmatozoa were discovered in the blood.

(*g*)—Prolonged gastric ingestion of rat's excrement.

Positive Result.—In Bombay Horse No. XCI.

Horse No. XCI.—Australian Gelding, aged 5 months; animal was, through the courtesy of Veterinary-Major J. Mills, located at the Veterinary College, Bombay, on May 6th, 1893, with a view to determine whether an animal can contract Surra, when the dung of rats, in whose blood the *Trypanosoma Evansi* is present at the time of collection, is mixed with the daily rations of the corn. This experiment commenced on the above date, and was continued until the 26th September 1893, a period of 144 days, during which time the temperature varied between 37·3°C. and 38·3°C., but only on two occasions touched the latter figures. As no symptom of Surra had supervened up to September 26th, it was decided to remove the horse to its original stable in Poona. For this purpose it was necessary that the animal should walk two and half miles to the Railway Station, and there be entrained for Kirkee Station, a distance of 116 miles, after which a further distance of two miles to the Laboratory Stable had to be covered. On September 27th, the animal arrived from Poona in good condition and appearing in perfect health. On the morning of the 28th, an urticarial eruption was present over the whole body together with other symptoms of Surra, and on microscopical examination of the blood, very numerous Surra hæmatozoa were discovered. On September 29th, treatment was commenced, Arsenic being administered as Liquor Arsenicalis. The first paroxysm of the disease lasted for six days from 28th September to the 3rd October inclusive. The organism was again discovered in the blood from the 30th October to 2nd November inclusive, after an intermission lasting twenty-six days. Some difficulty was found, however, in getting the animal to take the Arsenic, consequently some doses were omitted; nevertheless, from 2nd November to 4th January, a period of sixty-two days, no hæmatozoa were observed in the circulation. From the 5th until the 16th January, when death took place, the parasite was present in the blood, in small numbers, on 8 and absent on 4 days.

Autopsy.—Body somewhat emaciated, mucous membranes of mouth and lips pallid, nasal septum congested. No œdema of extremities, &c. *On section,* subcutaneous tissues stained a yellow colour, internally organs and membranes present an orange hue. *Thorax.*—No fluid in pleural cavities, no pleuritic adhesion. *Lungs* distended with air, few small sub-pleural extravasations of blood. *Pericardial sac.*—Few c.c. reddish-yellow coloured fluid. *Heart.*—Several sub-endocardial extravasations in Right ventricle, Left free. *Peritoneal cavity.*—No fluid. *Liver* old perihepatitis, few dark purple coloured petechiæ on convex surface of organ. *Spleen.*—Sub-capsular petechiæ. *Kidneys.*—Few minute petechiæ dotted over surface of the left organ, right free. *Stomach.*—Few *spiroptera* nests. *Intestines* present healthy appearance. *Bladder.*—Mucous membrane somewhat congested.

Negative Result.—In Poona Horse No. LXXV.

In Bombay Horse No. LXXXIX.

Horse No. LXXV.—An Australian Gelding, aged, was fed upon corn mixed with a varying quantity of the excrement of rats, in whose blood an organism resembling the Surra *Trypanosoma* was present at the time of collection. This experiment commenced on the 26th November 1892, and was terminated by the death of the animal on the 8th February 1893, a period of 74 days. During the whole period the temperature remained within normal limits, except on two occasions when it rose to 39°·3 and 40·1° C. on the evenings of the 22nd December 1892 and 1st January 1893, owing to the presence of a few maggots in the frog of one of the feet, this condition was immediately attended to on each occasion, and the temperature fell to 37·4 and 37·6° C. respectively.

Autopsy.—Body fairly well nourished, complete absence of swelling and œdema from extremities and under-surface of the abdomen. *Thorax.*—No adhesion of the pleuræ, but each sac contains a few ounces of a turbid, orange-coloured fluid. *Lungs.*—Apices emphysematous, sub-pleural petechiæ dotted over surfaces of the organs. *On section.*—Tissues dark in colour, on pressure a frothy blood-stained fluid exudes from the cut ends of the bronchial tubes. *Pericardial sac* contains 4 ounces of a turbid, orange-coloured fluid. *Heart.*—Enlarged, weighs 6 lbs. 14 ozs., gelatinous material round base and running down the course of the coronary vessels. Petechiæ lying underneath the epicardium and dotted over the surface of the above-mentioned material. *On section.*—Sub-endocardial extravasations, varying in number, in all the cavities. *Abdominal cavity,* few ounces of a turbid orange fluid. *Liver.*—7 lbs. 6½ ozs., old perihepatitis. *Spleen.*—Normal in size, studded with sub-capsular petechiæ. *Kidneys.*—Right 1 lb. 1 oz., Left 1 lb. Tissues dark, malphigian corpuscles very prominent. *Stomach, villous portion.*—Patch covered with ragged mucous membranes; few *spiroptera megastoma* scattered over surface of lining membrane. *Small Intestines.*—Arborescent vessels, small extravasations of blood between middle and lining membranes of the gut. *Cæcum.*—Ditto. *Bladder* healthy.

Horse LXXXIX.—This animal, an Australian gelding, aged, was located at the Veterinary College, Bombay, together with Horse XCI, on May 6th, 1893, and remained until 26th September, when it was sent back to the Laboratory Stables at Poona. During the period of 144 days the animal was subjected to the influence of the rat excrement in its food, no rise in temperature took place, and no symptoms of Surra were exhibited. This animal at a later date was subjected to inoculation with the Surra hæmatozoon, and after the appearance of the organism in the blood was put under treatment with Arsenic.

(*h*)—Subcutaneous inoculation with the blood of different animals, which had been primarily inoculated from Horse No. XCI (rat excrement ingestion).

Positive Results.—Horse No. XCV, Cat No. III, Guinea Pig No. XXIII.

Horse No. XCV.—Bay, Country-Bred Mare, aged, in fair condition. Inoculated subcutaneously on the 9th October 1893 with 1 c.c. of blood containing very numerous hæmatozoa, taken from the jugular vein of a Guinea Pig immediately after death, which latter had been previously inoculated from Horse No. XCI (Surra from rat excrement) on the 28th September 1893. The latent period occupied five days. Some swelling and œdema was present at the seat of the inoculation, accompanied by tenderness on manipulation. Next morning the tenderness disappeared and the swelling was found to be less tense, the hæmatozoon was found in the general circulation. From the day of inoculation until the end of the period of incubation, the temperature oscillated between 36·4° and 37·6°C. On the first appearance of the *Trypanosoma* in the blood the temperature rose rapidly and at midday, on the second day of the disease, registered 40·2°C. After this it gradually fell until on the fifth day of the paroxysm it was 38·4°C. Chloroform was administered and death took place on the afternoon of the 18th October 1893.

Autopsy at 3·30 p. m. on the same date. The body is fairly well nourished, adipose tissues stained an orange colour. The *pleural cavities* contain a few ounces of a blood-stained fluid. *Lungs* pale in colour, localized emphysema at the apices; several large sub-pleural extravasations of blood on both surfaces and anterior lobe of the left organ, and a few small isolated patches on the superior surface of the right. *Pericardial sac* contains 4 ozs. of a clear orange fluid.

Heart weighs 7 lbs. 15½ ozs. The base of the organ is surrounded by a considerable amount of an orange-coloured gelatinous material, dotted over its surface by dark-red coloured petechiæ, the external surface of the muscular tissue is free from ecchymoses with the exception of a few involving the right ventricle near the apex.

On section.—There are no sub-endocardial extravasations present, and the valves are healthy.

Liver weighs 14 lbs. 5½ ozs., somewhat enlarged, presents numerous, small hard, white-coloured nodules in its substance which were found, on section, to involve the structures of the whole organ.

Stomach.—On section, Cuticular portion healthy in appearance, *Villous* mucous membrane presents a pink colour; no ulceration or spiroptera tumours.

Spleen weighs 5 lbs. 10 ozs., considerably enlarged, nearly three times the normal weight. Surfaces dotted over with numerous small dark-purple coloured sub-capsular petechiæ. *On section* the tissues present a very dark-purple colour and are somewhat soft in consistency.

Kidneys.—Each weighs 1 lb. 6½ ozs., capsules strip easily, the cortical surfaces covered with very numerous small circular extravasations, which are found on section to invade the deeper structures.

Small and Large Intestines.—Healthy.

Cat No. III.—This animal was full grown and apparently in good health and condition. On 30th June 1894, after being under close observation since the 24th of the previous March, it was inoculated with 0·15 c.c. of blood, containing very numerous hæmatozoa, taken from a Guinea Pig, previously inoculated with blood from Horse No. XCI. The latent period occupied seven days. From the first appearance of the Surra organism in the blood, 7th July 1894, until death, 24th November 1894, one hundred and forty-one days elapsed; these were made up of 18 paroxysms lasting 60 days and 17 intermissions lasting 81 days; an average for paroxysms and intermissions of 3·3 and 4·76 days respectively. During the period of observation lasting 89 days, the temperature of the animal varied between 37·6° and 40·3°C. The highest reading during the whole length of the case was 40·8°C. and this occurred once in paroxysm VII, and once in intermission IX.

On the 128th day of the disease this animal became convulsed and these lasted day and night until the 132nd day evening on every two or three hours; but later on the 138th day of the disease the convulsive attacks again seized the animal and continued once in every 10 to 15 minutes until death on the 141st day.

Autopsy.—Body emaciated, no swelling or œdema of the limbs, both cornea opaque.

Thorax.—No fluid in the pleural cavities, no adhesions. *Lungs.*—Apices seat of localized emphysema, numerous sub-pleural ecchymoses. *Pericardial Sac* contains two drachms of fluid. *Heart* pale, otherwise healthy. *Abdominal cavity* free from fluid. *Stomach* and *Liver* present a healthy appearance. *Spleen* enlarged, convex surface dotted over with small irregular-shaped extravasations. *Kidneys* pale, cortical portion of each petechiated. *Intestines* healthy.

Brain membranes are pale, superficial vessels full of blood. *On section,* tissues appear healthy, some fluid in lateral ventricles.

Guinea Pig No. XXIII.—This animal was inoculated on 30th June 1894 with 0·15 c.c. of blood, containing very numerous hæmatozoa, taken from a Guinea Pig No. XXI immediately after death. The inoculated disease had been brought through Guinea Pigs XXI, XX, XIX, which latter was inoculated with blood from Horse No. CXI—disease produced from rat excrement in the food. The latent period occupied seven days. From the first appearance of the Surra organism in the circulation on July 7th, 1894, until death on August 11th, 1894, was thirty-six days. This period was made up of

three paroxysms lasting 32 days and two intermissions lasting 4 days. The third paroxysm occupied 28 days when death took place.

Autopsy.—Organs appear healthy. Body weight 347 grammes, spleen weight 1·7 grammes, ratio of spleen weight to body weight = 1 : 204.

(i) Transmission of the Hæmatozoon from the Mother to the Offspring through Suckling.

Result Positive.—Calf No. I.

Calf No. I.—This animal was about twenty-one days old when it was brought at the side of its mother. The cow was inoculated on the 28th August 1892 with Surra, and the hæmatozoon appeared in its blood on September 2nd, and remained present until the evening of the 6th. The calf was allowed to suck its mother three times daily, but during the intervals was tethered at some distance from, but in sight of, the cow. The milk from each teat was subjected to microscopical examination for a considerable period, but no sign of the hæmatozoon was discovered. Up to the morning of the 9th October, the 38th day from the appearance of the organism in the blood of the mother, no organisms had been observed in the blood of the calf, but on that date hæmatozoa of some length were found, which were also very active in their movements. From that day until the 9th February 1893, no more were observed, although careful examination of the blood was made daily. A point of considerable interest is observed on reference to the charts of the mother and the young one. In the case of the latter, the falls in temperature of the mother are faithfully recorded on that of the calf, and when the temperature of the cow became markedly of an intermittent type, it was recorded, and if anything, rather exaggerated in the temperature curve of the young one. The calf on February 9th, 1893, was in good condition and had grown considerably. It was, therefore, decided to re-inoculate it with Surra, with a view to determine what course, if any, the disease would take. Consequently, at 5 P.M. on the above date 1·0 c.c. of blood was subcutaneously injected, taken from Horse No. LXXXIV immediately after death. The hæmatozoon was numerous *ante mortem*. The latent period occupied only three days. The organism was present for two days, 13th and 14th February, and again for one day, 18th, after an intermission of 72 hours. From 18th February until September 30th, 1893, a period of 224 days, the organism was present in the blood once and then only for a few hours, *viz.* on the 22nd June, 124 days after its last appearance. The animal spontaneously contracted rinderpest, the first symptoms appearing on the 28th and succumbed to that disease on September 30th, 1893.

(j) Subcutaneous inoculation of Guinea Pigs with urine passed by animals during a paroxysm of Surra.

Negative Results.—Guinea Pigs Nos. I, II (Bull No. III). Guinea Pigs Nos. I, II (Donkey No. II).

Two Guinea Pigs Nos. I and II were each injected subcutaneously on the 8th August 1892 with 2·0 c.c. of urine passed one hour previously by Bull No. III. in whose blood hæmatozoa were swarming at the time. The urine was first allowed to settle for one hour, the supernatant liquid was then poured off and the remaining few cubic centimetres used for the purpose of injection.

No. I.—The hæmatozoon was absent during the period which elapsed between the injection and death which occurred on the 26th August after an interval of 18 days.

No. II showed no symptoms whatever referable to the urine, and after September 30th the blood was no longer submitted to examination. Results negative.

Two Guinea Pigs Nos. I and II were each injected subcutaneously with 2 c.c. of urine passed one hour previously by the donkey in whose blood the day previous hæmatozoa were swarming. The urine was first allowed to settle for one hour, the supernatant liquid was then poured off, and the remaining few cubic centimetres used for injection purposes.

No I showed no symptoms referable to the injection of urine, and after 30th September the blood was no longer submitted to examination.

No. II.—The animal showed no symptoms referable to the injection of urine, but twelve days after inoculation developed epidemic diarrhœa at that time prevalent and succumbed to it on August 21st, 1892. Results negative.

TABLE XXVIII.

Experimental Cases.

Appendix number.	No.	Kind of animal inoculated.	Fluid used for purpose of inoculation.	Quantity used for purpose of inoculation.	From what animal fluid used was taken.	Date of inoculation.	How administered.	Inoculation with fluid taken *ante-mortem*.	Number of Hæmatozoa present in fluid *ante-mortem*.	Inoculation with fluid taken *post-mortem*.	Fluid taken number of hours *post-mortem*.	Number of Hæmatozoa present in fluid taken *post-mortem*.	Result of inoculation, Positive or Negative.	Date of first appearance of Hæmatozoa in the Blood.	Number of days after inoculation. First appearance of Hæmatozoa in the Blood.	Result of inoculation.	Date of death.	Days between inoculation and death.	Remarks.
I	IX	Horse ...	Blood ..	1·0 c.c.	Rat (M. dec.)..	28th Dec. 1890.	Subcutaneous inoculation.	.....	.....	P.M.	Immediately	N.	P.	·15th Jan. 1891.	18	Death ...	3rd Feb. 1891.	37	
	XXVIII	,, ,,	,, ...	1·5 c.c.	Do. ...	2nd July 1891.	Do. ...	.....	.....	P.M.	Do. ...	S.	P.	31st July 1891.	29	Do. ...	2nd Aug. 1891.	31	
	XLII	,, ...	,, ...	2·0 c.c.	Do. ...	21st Sept, 1891.	Do. ...	.....	.....	P.M.	Do. ...	N.	P.	4th Oct. 1891 ..	13	Do. ...	6th Oct. 1891 .	15	
	LXII	,, ..	,, ...	2·0 c.c.	Do. ...	14th May 1892.	Do. ...	.....	.....	P.M.	Do. ...	V,N.	P.	16th July 1892 .	63	Do. ...	21st July 1892.	68	
II	XXXV	,, ...	,, ...	0·5 c.c.	Horse XXVIII.	2nd Aug. 1891.	Do. ...	A.M.	V.N.	.....	... ..	.....	P.	8th Aug. 1891 .	6	Do. ...	10th Aug. 1891.	8	From Rat—Horse XXVIII
	XXXVI	,, ...	,, ...	0·5 c.c.	Do. · XXVIII.	Do. ...	Do. ...	A.M.	V.N.	.....	.....	.....	P.	7th Aug. 1891 .	5	Do. ...	Do. ...	8	Do. XXVIII.
	XLV	,, ...	,, ...	1·0 c.c.	Do. XLII.	6th Oct. 1891...	Do. ...	A.M.	N.	.....	.....	.....	P.	22nd Oct. 1891 .	16	Do. ...	31st Oct. 1891 .	25	Do. XLII.
	LXVII	,, ...	,, ...	1·0 c.c.	Do. LXII.	21st July 1892..	Do. ...	A.M.	F.	.....	.....	.....	P.	30th July 1892 .	9	Do. ...	31st July 1892.	10	Do. LXII.
	XXXVII	,, ...	,, ...	0·7 c.c.	Do. XXXV.	10th Aug. 1891,	Do. ...	.....	.....	P.M.	6·5 hours ...	A.	P.	15th Aug. 1891.	5	Do. ...	17th Aug. 1891.	7	Do. XXXV.
III	LVII	,, ...	,, ...	2·0 c.c.	Rat (M. dec.)...	14th Jan. 1892.	Do. ...	.....	.....	P.M.	Immediately.	N.	N.	.....	.....	...	.....	...	
	LII	,, ..	,, ...	0·5 c.c. 0·5 c.c.	Do. ...	30th Oct. 1891. 19th Nov. 1891.	Do. ...	.....	.....	P.M.	Do. ..	N.	N.	.....	.....	...	.....	...	Blood mixed with 6 per cent. salt solution.
	XLIV	,, ..	,, ...	1·0 c.c.	Do. ..	2nd Oct. 1891...	Do. ...	.....	.....	P.M.	Do. ..	S.	N.	.....	.....	...	.....	...	
IV	XIII	,, ...	,, ...	0·6 c.c. 1·0 c.c.	Do. ...	22nd Jan. 1891. 12th Feb. 1891.	Directly into jugular vein,	.....	.....	P.M.	Do. ..	N.	N.	.....	.....	...	.....	...	Inoculation 1·0 c.c, blood, Horse (XIX) Surra, 29th April 1891.
	XII	,, ..	,, ...	1·0 c.c. 2·0 c.c.	Do. ...	21st Jan. 1891 . 12th Feb. 1891.	Subcutaneous inoculation.	.....	.....	P.M.	Do. ..	N.	N.	.....	.....	...	.....	,,,	Inoculation m ii blood, Horse (XIX) Surra, 5th April 1891.
	XLVIII	,, ...	,, ...	0·75 c.c. 0·75 c.c.	Do. ...	15th Oct. 1891. 30th Oct. 1891.	Do. ...	.....	.....	P.M.	Do. ...	N.	N.	.....	.....	...	.....	...	Inoculation 0·5 c.c. blood, Horse (L) Surra, 12th November 1891.
	XLVI	,, ..	,, ..	2·0 c.c.	Do. ...	15th Oct. 1891	Do. ..	.....	.....	P.M.	Do. ...	N.	N.	.....	.....	...	.....	...	Inoculation 1·0 c c. blood, Horse (XLVIII) Surra (P.M. 8½ hours),23rd November 1891.
	LVIII	,, ...	,, ...	2·0 c.c,	Do. ...	18th Feb. 1892	Do. ...	.....	.....	P.M.	Do. ...	V.N,	N.	.....	.....	...	.....	...	Inoculated 1·0 c.c, blood Horse (XLVII) Surra (P.M. 5, hours), 29th March 1892.
VI	LXIX	,, ...	,, ...	0·5 c.c.	Cow I ...	3rd Sept. 1892.	Do. ...	A.M.	S.	.....	.....	. ....	P.	8th Sept. 1892.	5	Death ...	22nd Sept. 1892.	19	
VII	LXXV	,, ...	Rat dung...	.....	Rat (M. dec.)...	26th Nov. 1892	By mouth ..	.....	.....	.....	.....	.....	N.	......	.....	...	.....	...	
	XCI	,, ...	,, ...	.....	Do. ...	6th May 1893...	Do. ...	.....	.....	.....	.....	.....	P.	28th Sept. 1893.	145	Death ..	16th Jan. 1894.	255	
	LXXXIX	,, ..	,, ..	.....	Do. ...	Do. ...	Do. ...	.....	.....	.....	.....	.....	N.	.....	.....	...	.....	...	Fed with 4 oz. Surra blood, Horse (XCIII).

TABLE No. XXVIII—*continued.*

Appendix Number.	Number.	Kind of Animal inoculated.	Fluid used for the purpose of inoculation.	Quantity of fluid used for inoculation.	From what animal fluid used was taken.	Date of inoculation.	How administered.	Inoculation with fluid taken *ante mortem.*	Number of Hæmatozoa present in fluid *ante-mortem.*	Inoculation with fluid taken *post mortem.*	Number of hours fluid taken *post mortem.*	Number of Hæmatozoa in fluid taken *post mortem.*	Result of inoculation, Positive or Negative.	Date of first appearance of Hæmatozoa in the blood.	Number of days after inoculation. First appearance of Hæmatozoa in the Blood.	Result of inoculation.	Date of death.	Days between inoculation and death.	Remarks.
V	IV	Bull ..	Blood ..	2·0 c.c.	Rat (M. dec.) ..	27th July 1892.	Subcutaneous inoculation.	....	....	P.M.	Immediately.	Few ..	P.	11th Oct. 1892.	76	..	....	..	
	II	Monkey ..	,, ..	1·5 c.c.	Do. ..	23rd Mar. 1893.	Do. ..	....	....	P.M.	Do. ..	N.	P.	26th Mar. 1893.	3	..	....	..	
	I	Field Rat (N. provicens).	,, ..	0·6 c.c.	Do. ..	13th Feb. 1891.	Do. ..	....	....	P.M.	Do. .	N.	P.	20th Feb. 1891.	7	Death ..	26th May 1891.	102	
	II	,, ,, ..	,, ..	0·4 c.c.	Do. ..	Do. ..	Do. ..	....	....	P.M.	Do. .	N.	P.	Do. ..	7	Do. ..	31st July 1891.	168	
	III	Field Rat..	,, ..	0·4 c.c.	Do. ..	19th June 1894.	Do. ..	....	....	P.M.	Do. .	S.	P.	27th July 1894.	38	Do. ..	22nd Aug. 1894.	64	
	IV	,, .	,, ..	0·5 c.c.	Do. ..	Do. ..	Do. .	....	....	P.M.	Do. ..	S.	P.	12th July 1894.	23	Do. ..	6th Aug. 1894..	48	
	III	Donkey ..	,, ..	1·0 c.c.	Do. ..	9th Mar. 1893..	Do. .	....	....	P.M.	Do. .	N.	N.	....	....	Do. ..	5th May 1893 ..	57	
	I	Monkey ..	,, ..	0·5 c.c.	Do. ..	5th Aug. 1891..	Do. ..	....	....	P.M.	Do. .	N.	N.	....	....	Do. ..	1st Oct. 1891 .	57	
	II	Cat ..	,, ..	0·5 c.c.	Do. ..	14th Jan. 1893 .	Do. .	....	....	P.M.	Do. ..	N.	N.	....	....	..	....	..	
	I	Rabbit ..	,, ..	0·2 c.c.	Do. ..	7th Dec. 1890	Do. .	....	....	P.M.	Do. .	N.	N.	....	....	..	....	..	
	II	,, ..	,, ..	0·5 c.c.	Do. ..	Do. ..	Do. ..	....	....	P.M.	Do. ..	N.	N.	....	....	..	....	..	
	III	,, ..	,, ..	0·5 c.c.	Do. ..	23rd July 1892.	Do. ..	....	....	P.M.	Do. ..	N.	N.	....	....	..	....	..	
	IV	,, .	,, ..	0·5 c.c.	Do. ..	Do. ..	Do. ..	....	....	P.M.	Do. ..	N.	N.	....	....	..	....	..	
	I	Guinea Pig.	,, ..	0·5 c.c.	Do. ..	19th Sept. 1891.	Do .	....	....	P.M.	Do. ..	F.	N.	....	....	..	....	..	
	II	,, ..	,, ..	0·5 c.c.	Do. ..	22nd Nov. 1891.	Do. ..	....	....	P.M.	Do. ..	N.	N.	....	....	..	....	..	
	III	,, ..	,, .	0·5 c.c.	Do. .	Do. .	Do. .	....	....	P.M.	Do. ..	N.	N.	....	....	..	....	..	
	I	Fowl ..	,, ..	0·3 c.c.	Do. .	28th Jan. 1891 .	Do. ..	....	....	P.M.	Do. .	N.	N.	....	....	..	....	..	
	II	,, .	,, ..	0·3 c.c.	Do. ..	Do. ..	Do. ..	....	....	P.M.	Do. ..	N.	N.	....	....	..	....	..	
VI	III	Bull ..	,, ..	1·0 c.c.	Horse LXVII ..	31st July 1892 .	Do. .	A.M.	V.N.	....	....	....	P.	3rd Aug. 1892.	3	..	....	..	
	II	Donkey ..	,, ..	1·0 c.c.	Do. .	Do. ..	Do. .	A.M.	V.N.	....	....	....	P.	4th Aug. 1892.	4	Death ..	25th Dec. 1892 .	147	
	I	Cow ..	,, ..	1·0 c.c.	Donkey II ..	28th Aug. 1892.	Do. .	A.M.	V.N.	....	....	....	P.	2nd Sept. 1892.	5	...	....	..	
	I	Cat ..	,, ..	0·5 c.c.	Do. .	Do. ..	Do. ..	A.M.	V.N.	....	....	....	P.	Do. ..	5	Death ...	20th Oct. 1892 .	53	
	I	Dog ..	,, .	0·6 c.c.	Do. ..	Do. ..	Do. .	A.M.	V.N.	....	....	....	P.	Do. ..	5	Do. ..	26th Sept. 1892.	29	
	II	Rabbit ..	,, ..	0·75 c.c.	Horse LXII ..	21st July 1891 .	Do. ..	P.M.	N	....	15 minutes .	....	P.	26th July 1891 .	5	Do. ..	12th Aug. 1891.	22	
	I	,, .	,, ..	0·75 c.c.	Do. ..	Do. ..	Do. ..	P.M.	N.	....	Do. ..	....	N.	....	....	..	....	..	
VIII	I	Bull .	,, ..	1·0 c.c.	Donkey II .	22nd Aug. 1892.	Do. .	A.M.	V.N.	....	....	....	N.	....	....	..	....	..	
	III	Cat ..	,, ..	0·15 c.c.	Guinea Pig .	30th June 1894.	Do. ..	....	....	P.M.	Immediately.	V.N.	P.	7th July 1894 ..	7	Death ..	25th Nov. 1894.	148	
IX	I	Guinea Pig.	,, .	0·15 c.c.	Do. .	Do. ..	Do. ..	....	....	P.M.	Do. ..	V.N.	P.	Do. ..	7	Do. ..	11th Aug. 1894.	42	
X	I	Calf ..	Milk ..	*Ad lib.*	Cow I	28th Aug. 1892.	By mouth.	A.M.	Absent .	....	....	....	P.	9th Oct. 1892 ..	42	..	....	..	
	II	Guinea Pig.	Urine ..	2·0 c.c.	Donkey II ..	8th Aug. 1892 .	Subcutaneous inoculation	A.M.	Do. ..	....	....	....	N.	....	....	..	....	..	
	I	,, ..	,, ..	2·0 c.c.	Do. ..	Do. ..	Do. ..	A.M.	Do. .	....	....	....	N.	....	....	Death ..	21st Aug. 1892.	13	
	II	,, .	,, ..	2·0 c.c.	Bull III ..	Do. ..	Do. .	A.M.	Do. .	....	....	....	N.	....	....	Do. ..	26th Aug. 1892.	18	
		,, .	,, ..	2·0 c.c.	Do. ..	Do. .	Do.	A.M.	Do. .	....	....	....	N.	....	....	..	....	..	

SECTION III.

Description of Experimental Researches, and Results of the same obtained at Poona.

In 1890, as no statistics were forthcoming with regard to the percentage of rats which contained the '*Trypanosoma*' in their blood, it was determined to make a careful microscopical examination of the blood of as many of these animals as possible. The results arrived at were as follows.

From November 1890 to May 1892, the blood of 349 rats was examined microscopically, hæmatozoa were found present in 106, and absent in 234, giving a percentage of 30·37 present, 69·63 absent.

At a later date the elucidation of further details was required, especially with regard to the number of organisms present in the circulation of each individual animal.

Naturally, when the number of organisms had to be determined, the easiest way would have been to use one of the Hæmocytometers for that purpose, but in practice it was found to be useless, for when very few parasites were present in the circulation of an animal, it frequently happened that although several could be observed in cover-glass preparations of blood, none could be found in the small quantity used for examination with the Hæmocytometer. Consequently, the number of parasites present in the samples of blood examined were expressed in terms of few (1 in a specimen to 5 in each field of the microscope with Zeiss Ocular IV, and Objective D), numerous (5 to 20), very numerous (20 to 50) and swarming over 50 in each field. The *Trypanosoma* in several fields of the microscope were counted and the mean taken. In this way from June 1892 to July 1894, the blood of 758 rats was submitted to examination with the following results:—

Table No. XXIX.

Showing the Rats (Mus decumanus) examined from June 1892 to July 1894, and the relative number of organisms in their circulation.

	Absent.	Few.	Numerous.	Very numerous.	Swarming.	Total rats examined.	Present.	Absent.
In field of microscope .	...	1—5	5—20	20—50	Over 50	...	...	...
Number of rats ...	443	107	66	66	76	758	315	443
Percentage	58·44	14·12	8·71	8·71	10·02	100·00	41·56	58·44

If we divide the Bombay year into two periods, (i) dry and hot (January to May inclusive), (ii) rainy and humid (June to December inclusive) we find that during the period November 1890 to July 1894, 421 out of a total of 1,107 rats examined contained the hæmatozoon in their circulation. It was present in 31·53 per cent. of the rats caught from January to May, and 40·31 per cent. of those obtained from June to December, or during the rainy season. Although in the hot season the hæmatozoon is present in the circulation of these animals, the organisms are very few in number, while during the latter period of the year they are far more numerous, the percentage of cases in which the hæmatozoa were very numerous or swarming being 24·00 in the dry season and 52·61 in the rainy season, or a ratio of 1 : 2·19.

From the above facts it became evident that the 'Surra' months, or those during which the disease appeared in equines, and those in which the blood of rats presented the maximum number of hæmatozoa, were identical, *viz.* the monsoon or rainy season, which varies according to the year, commencing in June or July and terminating in September or October. Consequently, during the following year we collected as many rats as possible during each month, with a view to determine the percentage of animals in which the parasite was present. At first there was some difficulty in obtaining so great a number of rodents, but at last we enlisted quite an army of helpers and at the end of the following April found our total 2,102.

The following table explains itself:—

Table No. XXX.

Showing the total number of Rats (Mus decumanus) examined in each month from May 1894 *to the end of April* 1895, *with the relative number of hæmatozoa in their circulation.*

Month.	Absent.	Few.	Numerous.	Very numerous.	Swarming.	Absent.	Present.	Total.
May...	33	9	4	1	1	33	15	48
June	42	6	1	4	5	42	16	58
July...	66	21	15	10	12	66	58	124
August	107	31	7	21	22	107	81	188
September	96	24	20	15	24	96	83	179
October	156	44	22	15	25	156	106	262
November	88	26	6	7	14	88	53	141
December	166	37	15	12	22	166	86	252

Month.	Absent.	Few.	Numerous.	Very numerous.	Swarming.	Absent.	Present.	Total.
January	126	20	10	9	9	126	48	174
February	110	16	10	8	6	110	40	150
March	176	18	17	6	15	176	56	232
April	225	30	12	10	17	225	69	294
Total ...	1,391	282	139	118	172	1,391	711	2,102
Percentage ...	66·17	13·42	6·61	5·61	8·19	66·17	33·83	100·00

Rats were obtained from six localities during the year. The results registered concerning the presence of the hæmatozoon in their blood from different places tallied very closely when the animals examined were sufficiently numerous for comparison. The percentage varied between 32·12 and 35·43 in animals taken from three localities.

Table No. XXXI.

Showing the percentage of the animals examined month by month in which the hæmatozoon was absent or present, from May 1894 to April 1895 inclusive.

1	2	3	4	5	6	7	8
Year and month.	Absent. %	Few. %	Numerous. %	Very numerous. %	Swarming. %	Absent. %	Present. %
1894.							
May	68·75	18·75	8·33	2·08	2·08	68·75	*31·25
June	72·41	10·34	1·72	6·89	8·62	72·41	27·59
July	53·22	16·93	12·09	8·06	9·67	53·22	46·78
August	56·91	16·48	3·72	11·17	11·70	56·91	43·09
September	53·63	13·40	11·17	8·38	13·40	53·63	46·37
October	59·54	16·79	8·39	5·72	9·54	59·54	40·46
November	62·41	18·44	4·25	4·96	9·92	62·41	37·59
December	65·87	14·68	5·95	4·76	8·73	65·87	34·13
1895.							
January	72·41	11·49	5·74	5·17	5·17	72·41	27·59
February	73·33	10·66	6·66	5·33	4·00	73·33	26·66
March	75·87	7·75	7·32	2·58	6·46	75·87	24·13
April	76·53	10·20	4·08	3·40	5·78	76·53	23·47
Mean average ...	66·17	13·42	6·61	5·61	8·19	66·17	33·83
Rainy season, June to October	59·59	15·53	8·01	8·01	10·85	59·59	42.41
Dry season, November to May	71·57	12·08	5·73	4·10	6·50	71·57	28·43

* Sudden rise in May 1894 due to rain during that month.

It will be seen in column No. 8 that the percentage of rats in which the organisms were present in the circulation was highest during those months which included the monsoon season, *viz.* July to October inclusive, and during the remaining months the percentage gradually decreased until April was reached. The difference between the maximum 46·78, and the minimum 23·47, percentages in July and April respectively, is 23·31 or nearly half (50 per cent.)

TABLE XXXII.

Showing the Rainfall of Poona from 1890 to 1895.

Month.	1890.	1891.	1892.	1893.	1894.	1895.
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
January	...	...	...	...	0·00	...
February	...	...	0·66	...	0·51	0·24
March	...	...	...	...	0·00	...
April	1·28	0 32	0·14	1·19	0·42	...
May	0 13	1·01	0·26	3·80	0·05	...
June	4·33	0·66	5·89	15·13	2·23	7·00
July	3·68	8·35	11·80	2·32	12·84	5·47
August	3·33	2·97	4·51	3·34	2·22	3·43
September	4·06	1·16	7·97	2·08	2·28	7·72
October	2·44	3·03	17·41	1·24	8·52	5·46
November	4·46	...	0 28	2·03	0·00	0·74
December	0·58	...	...	...	0·00	...
Total ...	24·29	17·50	48·92	31·13	29·07	30·06

The great majority of rats present the hæmatozoon in their circulation, but in varying numbers, some time during the rainy season. From our observations, the spleen attains its maximum size towards the end of the rains, and from that period the size of the organ gradually diminishes during the dry and hot season, until the advent of the following monsoon, unless occasional heavy rain falls between November and May.

It has been observed during the middle of the hot and dry season that when rain suddenly falls after a long period of drought (4 months), the percentage of animals in which the hæmatozoon is found increases rapidly in the first few days (7) following the fall. The percentage then rapidly falls, and a second maximum is reached during the fourth week. The increase of percentage in the first week was found to be 7·5, while the maximum in the fourth week was 11·0 per cent.

The presence in varying numbers of the hæmatozoon in the circulation of rats does not appear to produce any noticeable symptoms in the great majority of them. But some few rats, whose blood swarmed with the hæmatozoon, have succumbed to leucocytosis, with extravasations of blood, containing the organism, into the anterior chamber and vitrous humours of the eye, opacity of the cornea, enlarged spleens, and extravasations of blood, or in some cases ulceration of the mucous membrane of the stomach.

Several observers have stated that rats in whose blood the hæmatozoon is found, do not appear to show any pathological changes, as a consequence of the presence of such organism in their circulation. There is no doubt, however, that a considerable increase in the size of the liver and spleen takes place and frequently a certain degree of fatty degeneration of the former.

The following table shows the ratio found to exist in the different classes between the weight of the spleen and that of the body, in a total of 2,126 rats examined:—

TABLE XXXIII.

Showing the ratio of spleen weight to body weight, when the hæmatozoon is present or absent from the circulation of Rats (Mus decumanus) male and female, whose body weights are over or under sixty grammes.

Hæmatozoon present or absent in the blood.	Number of Rats.	Males under 60 grammes ratio S. to B. W.	Number of Rats.	Females under 60 grammes ratio S. to B. W.	Number of Rats.	Males over 60 grammes ratio S. to B. W.	Number of Rats.	Females over 60 grammes ratio S. to B. W.	Number of Rats.	Males and Females under 60 grammes ratio S. to B. W.	Number of Rats.	Males and Females over 60 grammes ratio S. to B. W.
Absent	186	1 : 228·4	171	1 : 232·2	455	1 : 205·5	578	1 : 203·3	357	1 : 230·3	1,033	1 : 204·3
Few	49	1 : 139·8	48	1 : 201·5	104	1 : 190·0	95	1 : 144·3	97	1 : 166·7	199	1 : 165·7
Numerous	44	1 : 136·6	32	1 : 166·8	37	1 : 154·3	29	1 : 137·4	76	1 : 147·4	66	1 : 146·9
Very numerous	47		28		22		23		76		45	
Swarming	78	1 : 107·2	55	1 : 119·2	23	1 : 137·9	22	1 : 87·5	133	1 : 112·0	45	1 : 108·1
Total ...	404	.....	334	.....	641	.....	747	.....	738	.....	1,388	.....
Present	218	1 : 125·7	163	1 : 157·4	186	1 : 169·1	169	1 : 131·2	381	1 : 139·3	355	1 : 149·9
Absent	186	1 : 228·4	171	1 : 232·2	455	1 : 205·5	578	1 : 203·3	357	1 : 230·3	1,033	1 : 204·3
Total ...	404	.....	334	.....	641	.....	747	.....	738	.....	1,388	.....

It will be seen from the above table that the ratio of the spleen to body weight increased, from a minimum in the absent cases, in regular gradation, according to the number of hæmatozoa present in the circulation of the rats.

The percentage increase in weight of the spleen in males and females under 60 grammes with the hæmatozoon in their blood was 60 per cent, while in those over 60 grammes it was 73 per cent., above the average weight of the spleen in rats, whose circulation was free from the organism.

About 60 per cent. of young rats from two to four months old, weighing up to 60 grammes, have the hæmatozoon present in their circulation, and usually in large numbers.

The hæmatozoon of the rat appears and disappears from the circulation at irregular intervals, thus producing paroxysms and intermissions, as is the case with the Surra *Trypanosoma* in equines, bovines and other animals.

TABLE XXXIV.

Showing the number of Hæmatozoa, red and white Corpuscles, in one cubic millimetre of the blood of Rats (Mus decumanus) together with their body weight and that of the principal organs and their respective ratios.

I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.
Serial Number.	Number in Case Book.	No. of organisms. (Abbreviations).	Hæmatozoa in blood 1 c. mm.	Number of red corpuscles in 1 c. mm. of blood.	Number of white corpuscles in 1 c. mm.	Ratio white corpuscles to red.	Ratio of hæmatozoa to red corpuscles.	Body weight of rat.	Spleen weight.	Ratio of Spleen weight to Body weight.
								Grammes	Grammes	
1	1,406	N.	6,233	6,350,000	4,400	1 : 1,443	1 : 1,016	85·0	1·70	1 : 50
2	1,140	V.N.	9,400	6,320,000	2,600	1 : 2,431	1 : 672	28·0	0·05	1 : 560
3	1,404	V.N.	11,200	6,970,000	8,600	1 : 810	1 : 522	51·0	0·25	1 : 204
4	1,402	V.N.	15,000	7,550,000	5,200	1 : 1,452	1 : 503	58·0	0·25	1 : 232
5	1,156	T.	51,200	4,850,000	11,000	1 : 441	1 : 95	58·0	1·45	1 : 40
6	1,171	T.	268,400	5,450,000	6,000	1 : 915	1 : 20	28·0	0·29	1 : 96
7	1,417	T.	292,000	6,060,000	19,000	1 : 319	1 : 21	42·0	0·71	1 : 59

Microscopical examination of saliva proved the absence of the *Trypanosoma*, when the hæmatozoon was swarming in the blood at the same time. Immediately, however, a slight wound of the mucous membrane of the mouth was made, the organisms were discovered in varying numbers according to the amount of blood mixed with the saliva.

The hæmatozoon was always found absent from the urine of rats, although swarming in the circulation at the time of collection.

It has been observed in a considerable number of cases that although the hæmatozoon may be present in vast numbers in the blood of pregnant rats, in no case has the organism been discovered in the circulation of the fœtus. Of 2,154 rats examined, 1,070 were males and 1,084 females. Seventy-seven females were pregnant, the hæmatozoon being present in the blood of 19, and absent from it in 58; or a percentage of 32·75 as against 67·25

Nematode worms, varying in number and dimensions—1 to 5 or 6 inches in length—were found in the stomachs of rats, in which the hæmatozoon was either present or absent. In some instances it was fully distended by the number of parasites present, and little room could have been available for food. In a total of 203 examined for parasites in 1893, nematodes were found in the stomachs of 40 or 19·75 per cent. Again, in 2,154 examined in 1894-95, nematodes were found in 23·58 per cent. It is of interest to note that during the rainy season—June to November—the percentage was 16·27, whilst during the months December to May it rose to 29·36 per cent. The percentage varied during the twelve months from 7·25 in July to 37·50 in April. Therefore the *nematodes* and the *Trypanosoma* were not at their maxima at the same time. This is accounted for by the fact that during the heavy rains the ground and sewers are washed and flushed daily and the rats do not obtain as food filthy material, which is seen so frequently during the hot season.

The hæmatozoon has never been found in the blood of the musk rat (*Sorex cœrulescens*) and mice (*Mus spicatus*) although a large number have been examined.

Up to the year 1890, all inoculation experiments with the soiled blood of rats had proved negative in their results; the animals employed being rats (*Mus decumanus*), dogs, cats, horses (6) and monkeys. In the case of one monkey the result was doubtful, for Vandyke Carter states that "on microscopical examination of the animal's blood, taken from a digit 18 and 24 hours after inoculation, two hæmatozoa and one hæmatozoon were respectively observed. It did not, however, seem quite certain that a reproduction of the rat's organism had taken place in the circulation of the monkey; but possibly this was so to a very limited extent."

Proof, then, was wanting as to whether the *Trypanosoma* of the rat was capable of producing Surra in horses and other animals. For the purpose of deciding the above question two series of experiments were instituted: (i) Inoculation of animals with the soiled blood of the rat (*Mus decumanus*), (ii) the gastric ingestion of rat's excrement.

I.—Inoculation of Animals with the soiled blood of the Rat.

The first experiments were made with equines, but subsequently many investigations with other species of animals were taken in hand. Between December 1890 and February 1892, twelve horses were subcutaneously inoculated with a small quantity of blood (1 to 2 c.c.) containing the hæmatozoon in varying numbers. Of these, four animals or 33·3 per cent. contracted Surra :—

No.	IX.—Period of incubation lasted			18	days, animal lived	19	days.
„	XXVIII.—	„	„	29	„	2	„
„	XLII.—	„	„	13	„	2	„
„	LXII.—	„	„	63	„	5	„

Of the remaining eight animals, four (Nos. LII, XIII, XII, XLVIII) were re-inoculated with soiled rat's blood, but with negative results a second time. It was later determined to test certain of these horses with Horse Surra blood, in order to determine whether any protection had been conferred from the previous inoculations with the rat hæmatozoon, and find whether the course of the subsequent disease would be modified in any way. For this purpose five animals were selected, three (Nos. XIII, XII, XLVIII) submitted on two, and two (Nos. XLVI, LVIII) on one occasion only to subcutaneous injections of rat's blood.

Table XXXV.

Horse Number.	Fluid used.	Quantity used.	How administered.	A.M. or P.M.	From what Animal.	Date of Inoculation.	Date of first appearance of hæmatozoon.	Latest period, length in days.	Death.	Days between the first appearance of hæmatozoa and death.
		c.c.								
XIII	Blood ...	1·0	Directly into jugular vein.	A.M.	Horse XIX	29 4 91	7 5 91	8	12 6 91	36
XII	„ ...	m. j	Subcutaneously ...	A.M.	Do.	5 4 91	11 4 91	6	26 4 91	16
XLVIII	„ ..	0·5	Do. ...	A.M.	Horse L	12 11 91	22 11 91	10	23 11 91	1
XLVI	„ ...	1·0	Do. ...	P.M.	Do. XLVIII ...	23 11 91	1 12 91	8	7 12 91	6
LVIII	„ ...	1·0	Do. ...	P.M.	Do. XLVII ...	29 3 92	7 4 91	9	3 5 91	27

It will be observed that far from the previous inoculation of rat's blood in any way producing immunity or modifying the disease in the horses, it (certainly) accelerated the course of the malady in several of the animals, and produced more virulent symptoms and pathological changes. So that we may assert that horses unsuccessfully inoculated and re-inoculated with the rat hæmatozoon, when subsequently inoculated with Horse Surra blood, show no protection from the former, but acquire the disease after an incubation period of six to ten days.

Although the latent period of Rat Surra was so prolonged in the first instance when inoculated from rat to horse—average 31 days,—it immediately returned to the normal period—average 7 to 8 days,—when a second horse was inoculated with the blood of the first affected. The latent period, however, becomes still more reduced, 5 days, when a third animal is inoculated with the blood of the second.

II.—The Gastric ingestion of rat's excrement.

The question as to how rats could cause Surra in horses was raised ; for the food would rarely, if ever, be soiled with the blood of these animals.

The following experiments were, therefore, undertaken with a view to ascertain whether the excreta of rats—in whose blood the infusorian was present at the time of its collection—could produce the disease when mixed with the grain of the horses under experiment. For this purpose, numerous rats were obtained, the blood of each being submitted to careful microscopical examination, and those animals in which the hæmatozoon was found to be present were placed in an iron wire-cage by themselves. When a sufficient number of these latter were obtained, the cage was placed over a metal plate, and the excrement which fell through was collected in the morning and evening, and mixed with the corn, and was given to the animals under experiment at 8 A.M. and 6 P.M. Every week the blood of the caged rats was again submitted to microscopical examination, and those in which the hæmatozoon was found to be absent, were discarded, and their places filled by fresh ones in which the organisms were found to be numerous.

It was recognised before commencing the experiment in Poona that the result might probably prove negative, on account of the dryness of the situation, but it was nevertheless considered worthy of a trial.

The first experiment (Horse No. LXXV) was commenced on the morning of the 26th November 1892, and was continued until the evening of the 7th February 1893, a period of seventy-four days. Small doses (grammes iii) were given at first, but these were varied later according to the amount of excrement obtainable. During the whole course of the case, the temperature never exceeded 38·1°C. except on two occasions. One might have been inclined to consider the negative result in this case as clear evidence of the innocuous properties of rat-dung, and its inability to produce Surra, but before doing so several points must be taken into consideration.

(i) Horse Surra is enzootic in Bombay with an average rainfall of 72·7 inches, and mean yearly humidity of 81 per cent. of saturation; but the reverse is the case in Poona, on the Deccan plateau at an elevation of 1,857 feet, with an average rainfall of 27·6 inches, and mean yearly humidity of 53 per cent. of saturation.

(ii) It is a well ascertained fact, and the statistics in this and Volume I, furnish the proof, that in Bombay the deaths from Surra as a rule commence in August or September, and new cases practically cease at the end of December. Consequently, this experiment was undertaken at too late a period of the year, and any future experiment in this line should be undertaken in Bombay, or at all events below the ghâts, towards the end of the hot weather, and continued through the rain, if necessary.

(iii) Another point which has been noticed in animals submitted to inoculation with rat's blood is that the hæmatozoon in the blood of rats (kept for any time in captivity, and fed on clean corn, &c.) appears to lose in virulence.

The positive cases which have been recorded in horses in this report were inoculated with blood taken from rats which had been caught only a few hours previous to their blood being used for the purpose of inoculation. Some species of rats are very clean feeders, *viz.*, *Nesokia providens*, but the *Mus decumanus* of this country is not so, and eats any food which is procurable; when no grain is obtainable, it having recourse to offal and fæcal matter.

For the above reasons, it was deemed advisable to make further experiments with the same end in view—in Bombay.

Two horses (Nos. LXXXIX and XCI) were therefore transported in May 1893 to Bombay, and through the courtesy of Veterinary-Captain J. Mills, were located at the Veterinary College Hospital at Parel. A regular supply of rats was maintained principally from the kennels at Bandora, and their blood was examined by Mr. Dhakmarvala. Morning and evening the excrement was collected, weighed and a known quantity mixed with the ration of corn, previous to its being given to the animals under experiment. The experiments commenced on the morning of May 6th, and were terminated on September 26th, 1893, on which latter date the two horses appeared to be in perfect health and presented a good condition. Later the animals were taken several miles to the railway station and were sent back to the Laboratory Hospital at Poona. A period, therefore, of 145 days, commencing during the hottest and driest part of the year (May) and carried on during the whole of the rains, was devoted to this experiment. The temperature according to the charts, kindly kept by Mr. N. D. Dhakmarvala, during the animal's sojourn in Bombay, never exceeded the limits of health, in fact, during prolonged periods the diurnal variation never differed more than $\frac{2}{5}$ths of a degree. It was not until 24 hours after the animals arrived in Poona on the Deccan plateau that an urticarial eruption made its appearance on horse No. XCI and the Surra hæmatozoon was discovered on microscopical examination of its blood. Of course it may be said that the animal simply contracted the disease in the ordinary way, from the fodder, &c., during the rains. We have, however, the fact before us that the control animal horse No. LXXXIX standing by it, and all other horses in the same stable remained healthy, which certainly points to the extreme probability of the animal under experiment having acquired Surra through the agency of rat excrement. The period (incubation) occupied in this case was from first to last 146 days.

The latent period in the case of experimental inoculation by gastric ingestion of small quantities of blood known to contain the hæmatozoon, and mixed with water (*vide* horse No. XX, Vol. I) occupied 130 days from the first, and 75 days from the final exhibition of the soiled blood, until the appearance of the hæmatozoon in the general circulation. Consequently, if we consider it probable that the cause of the outbreak at the Bombay Tramway Company's stables was due to the horses consuming rat-excrement in their rations of corn, and we take as an instance the outbreak of 1892, when three horses were attacked with Surra on the 12th and 14th September, these animals must have commenced the ingestion of the grain soiled with the damp excrement of the rat, about July 1st, 1892, according to the shorter, or on the 6th May 1892, according to the longer computation. The grain we must suppose is contaminated during the whole year, but certain changes in the rat excrement take place at different seasons, the most important being *dryness* after the rains in October, but which is still more accentuated during the hot weather, at the commencement of the rains the dung becomes soft, and remains so, thus allowing the lower forms of life present in it to be developed.

The above cause, namely rat excrement, may be means of some animals, especially in towns and those fed on corn, acquiring Surra, but it must be remembered that enormous numbers of equines, especially in the Punjab, North-West Province, and Burmah, contract the disease during certain years, and these animals are turned out in the open and have to find their own fodder. One point, however, is quite certain, whatever be the means by which an animal contracts Surra, when once a case of the disease exists, flies may be and are in many instances the means of spreading it to healthy animals, just as in the case of anthrax and rinderpest, the smallest trace of virulent blood, placed in contact with a small scratch of the skin of an animal will be sufficient to reproduce the disease in a few days.

Animals other than horses, which contracted the disease, were bovines, monkeys and field rats (*Nesokia providens*); while the rabbit, guinea pig, cat, dog and donkey proved refractory to the rat hæmatozoon. But all the above animals were very susceptible to the rat hæmatozoon, when it had been passed through the horse. Fowls proved refractory to the rat hæmatozoon, as also after its passage through the horse.

SECTION IV.

Remarks on some symptoms of Surra in Animals, following Inoculation of Soiled Rat's Blood.

Analysis of the principal symptoms.

(a).—Morbid Phenomena referable to the skin.

(1) *Eruption.*—In the course of this investigation we have observed a number of cases of urticaria, the rash appearing somewhat suddenly, and as a rule disappearing in the course of twelve hours. In one case, however, a second attack took place lasting three days, and in the case of a second animal which was submitted to the arsenical treatment, the eruption appeared four times in one hundred days.

The following is a short account of the cases observed, placed under the different groupings.

Subcutaneous inoculation with soiled Rat's blood.

Horse No. IX.—On the morning of the third day of the disease an urticarial form of eruption appeared, involving the skin of the whole body, together with œdema of all fore limbs. On the following morning no sign of the rash was visible. The temperature which at 8 A.M. registered 38°C., four hours later had risen to 40·5°C., and six hours from the first record being taken reached a maximum of 41·4°C. The hæmatozoa which were only few in the blood on the day prior to the appearance of the skin eruption, were very numerous during its persistence, but were absent on the day following. Forty-eight hours after the first appearance of the rash the temperature had fallen to 37·2°C. (or 4·2°C. equivalent to 7·56°F.).

Horse No. LXII.—Concurrently with the first appearance of the hæmatozoon in swarms in the circulation an urticarial eruption was observed, which at first involved both sides of the nose and head, but later extended to the skin of the throat, neck, shoulders and fore-arms, thence over the chest and abdomen to the thighs, both inner and external aspects. There was also œdema of all fore limbs. On the following morning the eruption had entirely disappeared. The temperature which had been gradually rising for the previous forty-eight hours, attained a maximum of 40·6°C. at noon, during the height of the eruption, but on the following morning had fallen to 38°C.

Rat's blood on two occasions, negative results, subsequent inoculation with Horse Surra blood.

Horse No. XIII.—This animal was inoculated twice with soiled rat's blood, containing hæmatozoa, but followed by no result, except swelling at the seat of the infections. Seventy-six days after the first operation the animal was inoculated with Horse Surra blood. On the fourth day of the disease an urticarial eruption appeared over the posterior and inner side of the thighs and the near shoulder. This faded in the evening. Again on the 15th day of the disease the eruption made its appearance, involving the neck, fore-limbs, shoulders and abdomen. On the 16th day the rash faded, but became more marked on the following day. The hæmatozoon on the first occasion was very numerous at the time of the eruption declaring itself, but the temperature which had attained a maximum on the day previously, was then on the decline 39·6°C. On the second occasion the urticaria developed on the first day of the third paroxysm of Surra, just after an intermission lasting three days. During the three days the organism was present in numbers noted as few, few, and numerous respectively. The temperature oscillated in the periods during which the rash was present between 39·6°C. and 38·2°C.

Horse No. LVIII.—This animal was inoculated with blood taken from the heart of a rat, containing very numerous hæmatozoa, result negative. After 41 days, re-inoculation was performed with Horse Surra blood. On the second day of the disease an urticarial eruption involving the head and neck was first observed. Later the rash involved the fore-limbs, chest and back, and by noon of the same day the inguinal regions and inner aspects of the thighs were covered by it. The hæmatozoon was present in large numbers in the circulation, and the temperature which 48 hours previous to the appearance of the eruption registered 38°C. now rose to 41·5°C. By six o'clock in the evening the rash commenced to fade, and at eight o'clock but little remained. On the following morning it had entirely disappeared.

Rat Surra through the horse to a cow and second horse.

Horse No. LXIX.—On the 3rd September 1892, this animal was subcutaneously inoculated with blood containing swarms of hæmatozoa taken from cow No. I. The urticarial eruption appeared on the morning of the second day of the disease, and invaded the skin of the hind limbs and groins. At this time the animal presented a dull appearance, the limbs were swollen and œdematous, hot, but not painful on manipulation. The temperature on the previous morning was 37·4°C., it gradually rose until at 6 P.M. on the evening the rash was present, it registered 41·2°C. On the morning of the third day of the disease no sign of eruption remained and the temperature had fallen 2°C. The hæmatozoon was swarming in the circulation, during the persistence of the rash, and for the four following days.

Prolonged gastric ingestion of rat's excrement mixed with corn.

Horse No. XCI.—The urticarial eruption appeared over the whole body, but especially involving the abdomen and thighs, on the day Surra was recognised. The rash persisted more or less for eight days. During this period the hæmatozoon was present for the first five and absent for the last three

days. The temperature varied between 37·2°C. and 40·4°C. A second invasion of the eruption occurred between the 34th and 44th day of the disease. At first the rash was confined to the thighs, but later appeared over the whole body. The animal had been subjected to treatment with Arsenic, and the first appearance of the second attack coincided with the first day of the second paroxysm. For the first two days the temperature was high, 40·2°C., but for the last eight, the thermometer recorded a maximum of 37·6°C. A third attack of urticaria was noticed on the 82nd and 83rd days of the disease. On this occasion the eruption selected the chest, fore-limbs and thighs, and the temperature remained very low, *viz.*, 36·2°C., maximum 37·4°C. A fourth time the rash made its appearance on the 99th and 100th day of the disease, two days before a paroxysm, but it faded immediately the hæmatozoon made its appearance in the blood. The temperature varied between 38·2° and 39·4°C.

We found that the urticarial eruption in the two naturally acquired cases of Horse Surra previously reported occurred on the first day of the disease, and was of the form known as 'urticaria evanida.' In the experimental cases of the same disease the conclusion arrived at was that the rash might show itself any time from 18 hours after inoculation until the 22nd day after the appearance of the organism in the blood. In the observations conducted with the rat *trypanosoma* we find that in the three animals, two of which Nos. LXII and IX contracted the disease by the subcutaneous inoculation of soiled blood, in the former the eruption appeared concurrently with the hæmatozoon on the first day of the disease, and in the latter on the 3rd day of the disease. In horse No. XCI, fed on rat excrement mixed with the ration of corn, the urticarial eruption was the first symptom which drew attention to the animal's condition; on this occasion it persisted for eight days, but returned for a period of ten days between the 34th and 44th days and again for 48 hours on the 82nd and 83rd days and yet again on the 99th and 100th days of the disease.

In both horses LVIII and LXIX the eruption remained visible for 12 hours in each case, on the second day of the disease, and in horse XIII it broke out on the fourth day for 12 hours, and again remained patent for 72 hours between the 15th and 18th days of disease. Out of the first 55 cases of Horse Surra under observation the urticarial eruption appeared in 12 or 21·81 per cent, while in the 19 cases now recorded in equines, directly or indirectly derived from the rat, it showed itself in 6 or 31·58 per cent.

Swelling and œdema at the seat of inoculation in experimental cases:—When an animal has been inoculated subcutaneously with the soiled Surra blood, collected either during a paroxysm, intermission or after several hours *post-mortem*, a considerable swelling as a general rule follows at the seat of inoculation. This tumour tends to increase in size for a varying number of days, becoming more tense and tender on manipulation; then, somewhat suddenly, is found, on examination, to have become soft and flaccid, so that little or no notice is taken by the animal if the tumour is pressed with the hand. If the blood be now examined microscopically, the hæmatozoon in animals inoculated with Horse Surra blood will be found to present the organism. The '*trypanosoma*' is localized in the tumour, until it leaves the swelling and becomes generalized through the circulation. In the previous results published with regard to Horse Surra, it was stated that "in one case only out of 22 which contracted the disease by experimental means, was the swelling absent from the seat of inoculation; but in this, from first to last, during a period of nine days, no swelling or thickening of the integument could be felt. The shortest time noted in horses during which the swelling attained its maximum and commenced to decrease in size, was 96 hours, and the longest 12 days, the average length of 21 cases being 6·7 days. Within a very few days after the appearance of the hæmatozoon in the blood, the tumour has usually decreased considerably in size, and after a fortnight, only a slight thickening of the skin can be noticed on careful examination."

Considerable variation in the results obtained has been observed in experimental horses subcutaneously injected with rat's blood, containing the '*trypanosoma*,' as will be seen in the following short notes of the animals submitted, under their respective headings.

SUBCUTANEOUSLY INOCULATED WITH SOILED RAT'S BLOOD.

Positive cases.

Horse No. LX.—Received 1·0 c.c. rat's blood, hæmatozoa numerous, in left scapular region. Swelling appeared on the following day, reached a maximum on the 12th day after inoculation, remained stationary, with regard to size and tension, until appearance of the hæmatozoon in the blood on the 19th day. The swelling then lost its tension and tenderness, and within a few days all signs of the tumour had disappeared.

Horse No. XXVIII.—Received 0·75 c.c. rat's blood in the shoulder and the side of the head. The former swelling had disappeared by the 10th day, whereas the latter only attained a maximum on the 15th day, but had disappeared by the next morning. The hæmatozoon did not appear in the circulation of the animal until 29 days after inoculation or 14 days after the subsidence of the local manifestations.

Horse No. XLII.—This animal received 1·0 c.c. rat's blood, hæmatozoa numerous, in the shoulder and in the neck. In both instances the swelling attained its maximum on the 13th, and the hæmatozoon appeared in the blood on the following day. Reduction in the size of the swelling then rapidly took place.

Horse No. LXII.—Subcutaneous injection of 2·0 c.c. rat's blood, organisms very numerous, on left scapular region. Maximum swelling 10th day, reduction commenced 11th day, total disappear-

ance of tumour 18th day. Hæmatozoon appeared in the circulation on the 64th day after inoculation, or 46 days subsequent to the disappearance of the local changes.

SUBCUTANEOUS INOCULATION WITH BLOOD DERIVED FROM POSITIVE CASES.

Horse No. XXXV.—Inoculated with 0·5 c.c. blood, hæmatozoa very numerous. The swelling reached a maximum on the evening of the sixth day, reduction in size and tension of the tumour, occurred on the morning of the eighth day, and the organism was then discovered in the blood. Death on the ninth day.

Horse No. XXXVI.—Inoculated with 0·5 c.c. blood, hæmatozoa very numerous. Maximum amount of swelling on the fifth day. Reduction in size and tension of tumour on the morning of the sixth day; organism discovered in the blood at the same time. Death ninth day.

Horse No. XLV.—Inoculated with 1·0 c.c. blood taken 2½ hours *post mortem*; hæmatozoa swarming at time of death. Swelling marked on the second day, but on the morning of the third every sign of it had entirely disappeared. The hæmatozoon was not discovered in the circulation until the 17th day. Animal fell dead suddenly on the 31st.

Horse No. LXVII.—Inoculated with 1·0 c.c. blood, containing few hæmatozoa. Swelling increased up to evening of 10th day. On the morning of the 11th day, sudden reduction in size and tension of the tumour. Hæmatozoa discovered in the blood. Death on the 12th day.

Horse No. XXXVII.—Inoculated with 0·7 c.c. blood taken 7½ hours *post mortem*; hæmatozoa very numerous just previous to death. Swelling and tension increased to P.M. on the 6th day. Morning of 7th day reduction of tumour; hæmatozoon first observed. Death on the 8th day.

With one exception, immediately the hæmatozoon made its appearance in the blood, reduction in the size and tension of the tumour took place.

SUBCUTANEOUS INOCULATION WITH SOILED RAT'S BLOOD.

Results Negative.

Horse No. LVII.—Inoculated with 2·0 c.c. rat's blood, hæmatozoa numerous. The swelling attained a maximum on the 4th day; all trace of the tumour disappeared on the 18th day after inoculation.

Horse No. LII.—(i) Inoculated with 2·0 c.c. rat's blood, hæmatozoa numerous. Swelling over left scapular attained a maximum on the 13th day, reduction of the tumour occupied three days. (ii) Re-inoculated with 2·0 c.c. of rat's blood, hæmatozoa numerous. Swelling increased up to 9th day, reduction occupied two days only.

Horse No. XLIV.—Inoculated with 1·0 c.c. of rat's blood, hæmatozoa swarming. Swelling attained a maximum on the 12th day. Reduction followed on the 13th, and by the 15th day only little thickening left.

SUBCUTANEOUS INOCULATION AND RE-INOCULATION, AT A LATER PERIOD, WITH SOILED RAT'S BLOOD, WITH NEGATIVE RESULTS; FURTHER INOCULATION OF THE SAME ANIMAL WITH SOILED *HORSE* SURRA BLOOD.

Results Positive.

Horse No. XIII.—(i) Inoculated 0·6 c.c. rat's blood, hæmatozoa numerous, directly into the jugular vein. (ii) Re-inoculated subcutaneously with 1·0 c.c. of rat's blood, hæmatozoa numerous. Swelling attained a maximum on the 11th day. (iii) Inoculated with *Horse Surra* blood 1·0 c.c., taken during an intermission. Swelling and tension increased up to the 8th day; on the 9th day hæmatozoon appeared in the blood, and tumour became reduced in size, &c. Tumour measured ½ inch in diameter on the 14th day.

Horse No. XII.—(i) Inoculated subcutaneously 1·0 c.c. rat's blood, hæmatozoa numerous. Swelling attained a maximum on the 4th day, and then remained stationary until the 8th day, later reduction took place. (ii) Re-inoculation, after 23 days, with 2·0 c.c. rat's blood, containing very numerous hæmatozoa. Swelling attained maximum on the 4th day and remained stationary; reduction later. (iii) Inoculation on muzzle with one minim of *Horse Surra* blood, hæmatozoa numerous. No swelling at seat of inoculation observed until 6th day; tumour ⅓rd inch in diameter, 7th day increased in size and very tender on pressure. Tumour reduced in size on the morning of the 8th day.

Horse No. XLVIII.—(i) Inoculated subcutaneously with 0·75 c.c. rat's blood, hæmatozoa numerous. Swelling attained a maximum, 3 inches diameter, on 2nd day. Reduction followed. (ii) Re-inoculated subcutaneously, in two places, with 0·75 c.c. rat's blood, hæmatozoa numerous. The swelling on the right side attained its maximum dimensions 3½ × 2½ inches on the 2nd day; remained stationary up to the 7th day, and had entirely disappeared on the 10th day. The tumour on the left side attained a maximum on the 2nd day—3×2 inches—and diminished in size on the 3rd day. (iii) Inoculated with 0·5 c.c. *Horse Surra* blood, no organisms, during an intermission of the disease. Not until the 9th day did a slight thickening occur at the seat of inoculation, otherwise nothing to point out the situation. The hæmatozoon was discovered in the blood on the 11th day. Death occurred on the same day.

Horse No. XLVI.—(i) Inoculated subcutaneously with 2·0 c.c. rat's blood, hæmatozoa numerous. Swelling attained a maximum on 5th day, remained stationary for three days, and finally disappeared on the 18th day. (ii) Inoculated with 1·0 c.c. *Horse Surra* blood, taken 9½ hours *post mortem*. No swelling at seat of inoculation until the 5th day; maximum attained on 8th, reduction on the 9th day, when hæmatozoon first discovered in the blood.

Horse No. LVIII.—(i) Inoculated subcutaneously with 2·0 c.c. rat's blood, hæmatozoa very numerous. Swelling at seat of inoculation increased up to 5th day; remained stationary, as regards its dimensions, up to the 8th day, and became reduced in size, finally disappearing on the 22nd day. (ii) Inoculated with 1·0 c.c. *Horse Surra* blood, obtained 5 hours *post mortem*; hæmatozoa previously swarming. The swelling at the seat of inoculation increased until the 6th day, when it measured 7 × 6 inches, and raised 1½ inches above the surrounding tissues. The hæmatozoon was discovered in the blood on the 10th day, concurring with the reduction in size of the tumour.

The average period of incubation of Surra in 15 horses inoculated with *ante-mortem* blood, containing the hæmatozoon, extended over a period of 5·78 days, and with blood drawn during an intermission of the disease 8·7 days; while in 14, inoculated with blood drawn on an average 7·46 hours *post mortem*, the latent period was 9 days. In the cases now recorded, injected with soiled rat's blood on one or more occasions, followed by negative results, and subsequently inoculated with *Horse Surra*, the latent periods also occupied varying periods according to the source from which the virulent blood was obtained.

In No. XII, *ante-mortem*, hæmatozoa numerous, latent period 6 days as against 5·78 days in the above-mentioned instances.

In Nos. XIII and XLVIII, *ante-mortem*, taken during intermissions, latent periods 8 and 10 days, average 9 days as against 8·7 days.

In Nos. XLVI and LVIII, drawn 8½ and 5 hours *post mortem* respectively, the latent periods were 8 and 9, average 8·5 days as against 9 days.

From the above it will be at once observed that the subcutaneous injection of blood, containing the hæmatozoon of the rat on one or two occasions, although followed by marked local manifestations at the seat of the injection, had practically no effect on the period of incubation of the subsequent attack of Surra in horses.

SUBCUTANEOUS INOCULATION WITH THE BLOOD OF DIFFERENT ANIMALS, WHICH HAD BEEN PREVIOUSLY INOCULATED FROM THE RAT.

Result Positive.

Horse No. LXIX.—Inoculated with 0·5 c.c. blood, containing swarms of hæmatozoa, taken from the cow. The swelling at the seat of inoculation was perceptible on the 3rd day, increased to P.M. on the 4th, remained stationary on the 5th day. From the appearance of the organism in the blood, size of tumour reduced, disappeared entirely 10th day.

SUBCUTANEOUS INOCULATION WITH THE BLOOD OF DIFFERENT ANIMALS, WHICH HAD BEEN PRIMARILY INOCULATED FROM HORSE *XCI* (*Rat excrement ingestion*).

Horse No. XCV.—Inoculated with 0·7 c.c. Guinea Pig blood, hæmatozoa very numerous. The swelling at the seat of inoculation increased until the 5th day. The reduction in size of the tumour and first appearance of the organism in the blood occurred on the morning of the 6th day.

The period of incubation of Rat Surra in experimental cases was much more prolonged than in the case of Horse Surra, the maximum being 63 and the minimum 13 days. The average time which elapsed, between inoculation and the first appearance of the hæmatozoon was about thirty-one days; but it immediately returned to the normal period, 7 to 8 days, when a second horse was inoculated with the blood of the first affected. When a third animal was inoculated with the blood of the second the latent period became still more reduced, *viz.*, to five days.

It will be unnecessary to re-capitulate the symptoms of Surra in equines produced by the simultaneous inoculation of soiled blood obtained from the rat, for in those animals which survived the appearance of the hæmatozoon in the circulation for more than a few days, the characteristic features of the disease were similar to those described under Equine Surra, as occurring in the spontaneous and inoculated forms of the disorder. In several cases, the course of the disease was considerably accelerated, death taking place within forty-eight to one hundred and twenty hours after the *trypanosoma* had been discovered in the blood. There can be no question that this form of Surra acquired from the rat produces in the horse a most virulent type of infection, consequently no time is allowed for the development of the characteristic symptoms which are so marked a feature in the more chronic cases of the same malady.

In this volume the pathological changes found at the autopsies have not been analysed at length, a ; in Volume I. Short accounts of the conditions found *post-mortem* accompany each case and will be seen on reference to the respective Appendices

TABLE

Showing the number of Paroxysms and Intermissions which occurred in the course of each case, together with during the

Number of Appendix.	Number.	Animal.	Fluid used.	Quantity used.	Fluid taken from what animal.	Ante Mortem or Post Mortem.	Date of Inoculation.	How administered.	Latent Period. Length in days.	Latent Period. Maximum and minimum temperature °C.	Hæmatozoon. Date of first appearance.	Hæmatozoon. Temperature at time of first appearance.	I Paroxysm. Length in days.	I Paroxysm. Maximum and minimum temperature °C.	I Paroxysm. Maximum number of Hæmatozoon.
I	LXII...	Horse ...	Blood ...	c. c. 2·0	(Mus decumanus) Rat ..	... P.M.	..... 14th May 1892 ...	Subcutaneous Inoculation ...	63	39·9 36·4	16th July 1891 ...	39·3	6	40·6 37·4	S
	XLII...	,, ...	,, ...	2·0	,, ...	P.M.	21st September 1891.	,, ...	13	39·2 35·7	4th October 1891.	39·0	3	40·0 37·6	S
	XXVIII...	,, ...	,, ...	1·5	,, ...	P.M.	2nd July 1891 ...	,, ...	29	39·6 35·8	31st July 1891 ...	38·0	3	38·7 37·0	VN
	IX...	,, ...	,, ...	1·0	,, ...	P.M.	28th December 1891.	,, ...	18	39·2 36·4	15th January 1891	39·2	3	41·3 37·7	VN
II	XXXV...	,, ...	,, ...	0·5	Horse No. XXVIII	A.M.	2nd August 1891.	,, ...	6	37·8 37·1	8th August 1891 .	38·4	2	38·4 37·4	VN
	XXXVI...	,, ...	,, ...	0·5	,, XXVIII	A.M.	Do. ...	,, ...	5	37·2 36·0	7th August 1891 .	36·2	4	38·0 35·8	S
	XLV...	,, ...	,, ...	1·0	,, XLII	A.M.	6th October 1891	,, ...	16	39·9 35·5	22nd October 1891.	37·4	5	40·6 37·2	S
	LXVII...	,, ...	,, ...	1·0	,, LXII	A.M.	21st July 1892 ...	,, ...	9	39·3 36·4	30th July 1892 ...	39·3	2	40·0 39·3	VN
	XXXVII .	,, ...	,, ...	0·7	,, XXXV	P.M.	10th August 1891.	,, ...	5	36·3 35·1	15th August 1891.	35·8	3	38·2 35·8	VN
IV	XIII...	,, ...	,, ...	1·0	,, XIX	A.M.	29th April 1891 ...	,, ...	7	38·4 37·4	7th May 1891 ...	37·4	5	40·5 37·4	VN
	XII...	,, ...	,, ...	Fraction of Minim i ...	,, XIX	A.M.	5th April 1891 ...	Scratch on muzzle	6	38·6 38·1	11th April 1891 ...	38·6	7	40·9 39·5	VN
	XLVIII...	,, ...	,, ...	c. c. 0·5	,, L	...	12th November 1891.	Subcutaneous Inoculation ...	10	40·0 35·6	22nd November 1891.	37·0	1	38·8 37·0	N
	XLVI...	,, ...	,, ...	1·0	,, XLVIII	P.M.	23rd November 1891.	,, ...	7	38·3 35·6	1st December 1891.	38·1	7	40·1 36·8	S
	LVIII...	,, ...	,, ...	1·0	,, XLVII	P.M.	29th March 1892 .	,, ...	8	40·4 38·1	7th April 1892 ...	39·5	5	41·5 39·5	VN
V	IV...	Bull ...	,, ...	2·0	(Mus decumanus.) Rat ...	P.M.	27th July 1892 ...	,, ...	76	41·0 37·4	11th October 1892.	37·8	1	89·1 37·8	F
	II...	Monkey ...	,, ...	1·5	,, ...	P.M.	23rd March 1893 .	,, ...	3	39·2 38·2	26th March 1893.	38·4	1	39·2 38·4	F
	I...	Field Rat (Nesokia providens).	,, ...	0·6	,, ...	P.M.	13th February 1891.	,, ...	7	...	20th February 1891.	...	22	...	VN
	II...	,, ...	,, ...	0·4	,, ...	P.M.	Do. ...	,, ...	7	...	Do. ...	...	28	..	N
VI	III...	Bull ...	,, ...	1·0	Horse No. LXVII	A.M.	31st July 1892 ...	, ...	3	40·3 38·5	3rd August 1892.	39·5	7	41·4 39·3	S
													5	41·4 38·0	S
														VIII.	
	I...	Donkey ...	,, ...	1·0	Horse No. LXVII	A.M.	Do. ...	,, ...	4	39·3 37·2	4th August 1892 .	38·0	4	42·0 38·0	S
														XV.	
													4	41·2 38·5	N
													5	41·9 39·0	S
	I...	Cow ...	,, ...	1·0	Donkey I...	A.M.	28th August 1892.	,, ...	5	39·3 38·0	2nd September 1892.	39·3		VIII.	
													1	40·2 39·9	F
	I...	Cat ...	,, ...	0·5	Donkey I...	A.M.	Do. ...	,, ...	5	39·2 38·4	Do. ...	39·0	3	40·4 39·0	S
	I...	Dog ...	,, ...	0·6	Donkey I...	A.M.	Do. ...	,, ...	5	39·8 38·6	Do. ...	38·9	10	40·0 38·2	VN
	LXIX...	Horse ...	,, ...	0·5	Cow 1 ...	A.M.	3rd September 1892.	,, ..	5	39·3 36·7	8th September 1892.	37·4	7	41·2 37·4	S
	II...	Rabbit ...	,, ...	0·75	Horse No. LXII	P.M.	21st July 1892 ...	,, ...	5	40·5 39·4	26th July 1891 ...	41·2	1	41·6 41·2	F
VII	XCI...	Horse ...	Rat excrement.	Small amount daily.	.....	...	6th May 1893 ..	By month ...	145	...	28th September 1893.	38·8	6	40·3 37·7	VN
IX	I...	Calf ...	Milk ...	Ad libitum.	Cow I ...	A.M.	28th August 1892.	,, ...	42	40·4 37·4	9th October 1892.	37·8	1	39·5 37·8	F

XXXVI.

their duration, maximum and minimum temperatures, and the maximum number of hæmatozoa present former.

I Intermission.		II Paroxysm.			II Intermission.		III Paroxysm.			III Intermission.		IV Paroxysm.			IV Intermission.		V Paroxysm.			V Intermission.		VI Paroxysm.			VI Intermission.		VII Paroxysm.			VII Intermission.	
Length in days.	Maximum and minimum temperature. °C.	Length in days.	Maximum and minimum temperature °C.	Maximum number of Hæmatozoa.	Length in days.	Maximum and minimum temperature °C.	Length in days.	Maximum and minimum temperature °C.	Maximum number of Hæmatozoa.	Length in days.	Maximum and minimum temperature °C.	Length in days.	Maximum and minimum temperature °C.	Maximum number of Hæmatozoa.	Length in days.	Maximum and minimum temperature °C.	Length in days.	Maximum and minimum temperature °C.	Maximum number of Hæmatozoa.	Length in days.	Maximum and minimum temperature °C.	Length in days.	Maximum and minimum temperature °C.	Maximum number of Hæmatozoa.	Length in days.	Maximum and minimum temperature °C.	Length in days.	Maximum and minimum temperature °C.	Maximum number of Hæmatozoa.	Length in days.	Maximum and minimum temperature °C.
Death.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Death.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Death.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
3	39·3 37·2	2	40·8 38·4	N	6	40·1 37·4	6	39·0 37·8	S	Death.		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Death.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Death.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
3	39·1 37·1	2	39·8 36·7	VN	Death.		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Death.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Death.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
2	40·4 38·8	9	40·2 37·7	N	3	39·6 38·0	7	39·7 38·3	VN	2	38·6 37·2	5	39·6 36·5	N	1	38·4 36·5	2	37·4 36·0	S	Death.		...	...	...	...	...	...	...	...	...	...
3	40·2 39·4	5	40·3 37·8	VN	Death.		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Death.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Death.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
3	39·6 38·1	3	42·1 38·1	S	2	39·1 38·0	6	41·7 38·5	VN	2	40·7 39·4	3	41·3 40·0	VN	2	40·2 38·8	1	42·0 398.	F	Death.		...	...	...	...	...	...	...	...	...	...
200	42·1 36·3	2	39·7 37·4	F	77	40·5 36·2	1	39·2 38·2	F	195	40·1 37·0	Death.		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	Discontinued after 119 days																													
3	...	17	...	N	Death.		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Death.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
13	40·2 38·0	2	40·2 39·0	F	9	40·3 38·6	1	39·3 38·5	F	207	41·6 35·7	1	40·7 38·3	F	109	42·0 35·6	3	40·0 38·0	VN	9	38·8 37·1	3	40·4 37·4	F	58	40·1 36·4	Death.		...	...	...
2	40·4 39·3	7	41·2 39·3	VN	2	40·8 40·2	5	41·3 39·3	VN	2	40·2 39·3	3	41·2 39·3	VN	1	39·7 39·2	4	41·2 38·0	VN	2	39·6 38·0	3	41·8 38·0	S	4	40·7 38·0	1	41·6 38·0	VN	2	40·2 37·6
	VIII.		IX			IX		X			X		XI	...		XI		XII			XII		XIII			XIII		XIV			XIV
4	40·3 38·0	2	40·8 40·0	VN	1	40·2 39·3	1	39·3 39·3	F	1	39·3 37·6	3	41·2 39·3	S	2	40·3 38·0	5	41·0 37·4	S	5	39·3 37·5	3	40·6 39·5	VN	5	39·4 38·4	2	39·4 38·2	N	5	41·4 38·2
	XV.		XVI			XVI		XVII			XVII		XVIII	...		XVIII		XIX			XIX		XX			XX		XXI			XXI
10	40·6 37·1	4	40·4 37·0	N	6	39·5 37·0	2	40·5 38·0	N	5	40·2 26·6	3	40·4 37·6	VN	6	40·6 35·5	2	42·0 38·6	S	6	40·4 36·0	1	40·3 38·5	VN	4	39·8 38·3	2	39·4 35·0	N	Death.	
55	40·2 37·5	1	40·6 39·5	F	18	39·6 37·0	1	39·4 37·0	F	21	39·8 36·6	2	40·0 38·0	F	66	40·2 36·4	1	39·3 38·2	F	10	39·5 37·1	1	39·6 38·6	F	22	40·4 37·1	2	41·1 38·5	F	70	41·4 36·4
	VIII.		IX			IX		X																							
9	39·8 36·7	1	39·6 38·1	F	36	40·3 37·0	2	41·4 39·0	F	...	...		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1	39·0 38·8	7	40·8 39·1	VN	1	40·6 40·2	2	40·8 40·4	F	1	40·5 40·0	8	41·4 40·3	F	2	40·8 40·2	25	41·2 38·7	F	Death.		...	...	...	...	...	...	...	...	...	...
1	39·6 39·3	4	40·2 39·2	VN	2	40·5 40·1	8	40·4 38·9	S	Death.		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
2	39·3 37·6	5	40·2 37·3	S	Death.		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
5	40·8 40·1	2	41·0 40·2	F	6	41·8 40·2	3	41·7 40·3	F	1	41·1 ...	Death.		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
26	39·9 35·7	4	40·3 36·4	N	63	40·0 36·0	2	39·7 39·4	F	4	39·6 38·1	6	39·2 37·8	F	Death.		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
126	40·3 36·1	2	40·8 39·4	F	3	40·4 38·2	1	39·5 38·0	F	123	40·1 37·0	1	38·6 37·7	F	109	40·2 37·8	Death.		...	...	...	...	...	...	...	...	...	...	...	...	...	...

PART IV.

THE EXPERIMENTAL INOCULATION OF ANIMALS WITH THE SOILED BLOOD OF THE BANDICOOTS.

D 2201—32

SECTION I.

Descriptive account of the Bandicoot *Mus* (*Nesokia*) *Giganteus*.

The *Mus* (*Nesokia*) *Giganteus*, according to Sterndale,* is known as the Bandicoot (Jerdon's No. 174). The native names are *Indur* Sanscrit; *Ghunse* Hindi; *Ikria* Bengali; *Heggin* Canarese; *Pandi-koku*, *i.e.*, pig rat, Telegu; *Oora-Meyoo* Singhalese. Its habitat is throughout India and Ceylon.

Description.—Fur coarse, consisting of the three kinds, of which the coarser piles are very long, and almost hide the general pilage on the lumbar and dorsal regions. These piles are almost absent on the head, neck and sides; general colour earthy brown, with yellowish hairs intermixed; the piles blackish-brown; under-parts dusky brown, mixed with grey; limbs brownish; nose, inside of ear and feet flesh coloured; tail black, ringed, and sparsely haired. The female has twelve mammæ. *Size*—head and body from 12 to 15 inches; tail from 11 to 13, weight about 3 lbs. "This is a well known rat, but it is not common in Calcutta, although supposed to be so. People frequently mistake very large specimens of the common brown house rat (*Mus decumanus*) for this animal, which, Blyth remarks, is rare here. Jerdon states that it is common in the fort of Madras, where he killed many, some of large size; when assailed it grunts like a pig, hence its Telegu name *Pandi-koku*, from which the word Bandicoot is derived. McMaster states that the Bandicoot, though so formidable in appearance, does not show so good a fight as an ordinary English rat, being a sluggish and cowardly animal; and though from its size and weight it takes a good deal of worrying, it seldom does much in self-defence, and any moderately good dog can kill it with ease. It is, however, a most destructive animal, doing much damage to grainaries, gardens and even poultry-yards. In some parts of the country, as for instance Fort St. George in Madras, Government used to pay a reward of one anna for every Bandicoot killed within the walls.

SECTION II.

Historical Reference.

The only reference of any kind appears to be the following from Vandyke Carter's observation. He states: "A few examples examined of *Mus Bandicottus* and of *Sorex species* (also of mice) gave negative results."

When examining the blood of rats in 1892 in Poona, it appeared probable to us that as Bandicoots are so difficult to distinguish when young from rats (*Mus decumanus*), and as they appear to live under very similar conditions and are foul feeders, in all probability the hæmatozoon would also find in their circulation a suitable habitat to thrive in.

There is no doubt that on the island of Bombay Bandicoots were, some few years ago, very numerous, especially in the native city. It was the exception, when driving through that quarter during the day, not to come across one or two running along the sewage channels from one shelter to another, although the streets at the time were crowded with pedestrians and general traffic. In the evenings, during the season for the exportation of grain from the Docks, the G. I. P. Railway station-yard, near to the stacked sacks of grains, was simply alive with Bandicoots of all ages and sizes, and it can be readily imagined the amount of damage such animals would do to the wheat in one night. In Poona also large numbers were to be found, but not by any means easy to catch alive; for specially large traps were required and even then, as in the case of rats, none would enter the trap after others had been caught in it, until the trap had been thoroughly cleaned and scalded with boiling water.

SECTION III.

Experimental investigations regarding the hæmatozoon in the blood of Bandicoots.

As perhaps the statistics collected concerning these animals may be of use in the future, we give the account in full, together with the ratio of spleen to body-weight, in a few cases towards the end of the list; the ratio of liver to body-weight is also added.

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* Natural History of the Mammalia of India and Ceylon, Calcutta, Thacker, Spink & Co., 1884. p. 319.

Complete list of Bandicoots 150 in number.

No.	Date.	Body Weight.	Spleen Weight.	Stomach.	Sex.	Hæmatozoa.	Ratio of spleen to Body Weight.	Locality.	Remarks.
	1894.	Grammes.	Grammes.						
1	July 21...	460	1·71	Healthy... ...	F.	A.	1 : 269·0	Bamburda village	
2	„ 24...	238	0·63	„	M.	N.	1 : 377·0	„	
3	August 1...	242	0·34	Ulcers	F.	A.	1 : 711·8	„ ...	Absent at death and for 19 days previous.
4	„ 5...	293	1·32	Healthy... ...	M.	S.	1 : 222·0	Camp	Inoculated small Guinea Pig (3 months) inguinal region ; one small rabbit (4 months) ear ; each 0·2 c.c.
5	„ 6...	890	2·50	Nematodes ...	F.	A.	1 : 356·0	Bamburda village	Body weight —Weight of young ones 890—103 = 787 grammes (1 : 315).
6	„ 7...	1134	1·65	„ ...	F.	A.	1 : 687·0	.....	About 1½ ounces of worms and food. 1134—56 grammes weight of stuff in stomach (1 : 653).
7	„ 11...	268	0·95	Healthy... ...	F.	A.	1 : 282·1	Bombay ...	Bombay Tramway Company.
8	„ ...	108	0·30	„	F.	A.	1 : 360·0	„ ...	„ „
9	„ ...	117	0·30	„	F.	A.	1 : 390·0	„ ...	„ „
10	„ ...	145	0·40	„	M.	A.	1 : 362·5	„ ...	„ „
11	„ ...	87	0·36	Few petechiæ ...	M.	F.	1 : 141·6	„ ...	„ „
12	„ ...	178	0·95	Healthy... ...	M.	A.	1 : 187·3	„ ...	2 young rabbits, 1 Guinea Pig inoculated.
13	„ ...	122	0·80	„	F.	S.	1 : 153·3	„ ...	Bombay Tramway Company.
14	„ ...	448	2·00	„	M.	A.	1 : 224·0	„ ...	„ „
15	„ ...	469	4·65	Nematodes ...	M.	A.	1 : 100·1	„ ...	Diseased Liver. Tape-worms in Trachea.
16	„ 18...	359	0·95	Healthy... ...	M.	A.	1 : 377·9	„ ...	Bombay Tramway Company.
17	„ ...	711·5	3·10	Nematodes, small petechiæ.	M.	A.	1 : 229·5	„ ...	„ „
18	„ 22...	670	1·70	Petechiæ, ulcer, nematodes.	F.	A.	1 : 394·1	„ ...	Liver diseased.
19	„ ...	540	2·62	Nematodes, ulcer.	F.	A.	1 : 206·1	„ ...	„ (young ones).
20	„ ...	590	2·35	Ulcer	F.	A.	1 : 251·0	„ ...	„
21	„ ...	552	2·10	Petechiæ ...	F.	A.	1 : 262·9	„ ..	„
22	„ ...	455	0·95	Ulcer	F.	A.	1 : 468·4	„ ...	„ Leucocytosis.
23	„ 23...	600	2·39	2 petechiæ ...	M.	A.	1 : 251·0	Poona city ...	Liver diseased.
24	„ 25...	63	0·20	Petechiæ ...	M.	A.	1 : 315·0	Bombay ...	Small.
25	„ ...	51	0·35	„ ...	M.	A.	1 : 145·5	„ ...	Small.
26	„ ...	56	0·21	„ ...	M.	F.	1 : 266·6	„ ...	White corpuscles increased in number. Small.
27	„ ...	53	0·20	Extra blood ...	M.	A.	1 : 265·0	„ ...	Small.
28	„ ...	57	0·21	Petechiæ ...	M.	A.	1 : 273·9	„ ...	Small.
29	„ ...	437	0·70	Healthy... ...	F.	A.	1 : 624·3	„ ...	Half-grown.
30	„ ...	240	0·60	„	F.	A.	1 : 400·0	„ ...	White corpuscles increased in number. Half-grown.
31	„ ...	315	4·60	Nematodes ...	M.	S.	1 : 78·5	„ ...	Corpuscles run together, white increased. Half-grown.
32	„ .	181	0·35	Healthy... ..	F.	A.	1 : 517·1	„ ...	Half-grown.
33	„ ...	540	1·50	Ret nematodes ...	F.	A.	1 : 360·0	Poona Club ...	
34	„ 28...	296	1·72	Petechiæ ...	M.	A.	1 : 172·0	Bombay ...	
35	„ ...	498	0·80	Healthy... ..	M.	A.	1 : 622·5	„ ...	
36	„ ...	126	0·52	„	F.	A.	1 : 242·3	„ ...	
37	„ ...	253	2·95	Nematodes ...	F.	A.	1 : 85·76	„ ...	Pregnant.
38	„ ...	521	0·97	„ ...	M.	A.	1 : 537·0	„ ...	Liver diseased. Pregnant.
39	„ 31...	926	1·72	Healthy... ...	F.	A.	1 : 538·4	Camp ...	„ „
40	September 1...	321	2·09	Full nematodes .	F.	A.	1 : 153·5	Bombay ...	White corpuscles increased.
41	„ ..	239	2·42	„ ...	F.	A.	1 : 98·76	„ ...	
42	„ ...	238	0·63	Ulcerated ...	M.	N.	1 : 377·0	„ ...	
43	„ ...	220	2·30	Full nematodes .	M.	A.	1 : 95·65	„ ...	White corpuscles increased.
44	„ 7...	377	1·10	Healthy	F.	A.	1 : 342·7	„ ...	Liver diseased. Pregnant (several born).
45	„ 9...	720	2·15	Full nematodes .	M.	A.	1 : 334·9	Poona city ...	White corpuscles increased.
46	„ 11...	253	1·40	Nematodes ...	M.	A.	1 : 180·7	Bombay ...	
47	„ ...	225	1·16	Healthy... ...	F.	A.	1 : 193·9	„ ...	
48	„ ...	203	1·23	„	M.	A.	1 : 165·0	„ ...	
49	„ ...	358	1·71	Ulcer and nematodes	M.	A.	1 : 209·3	„ ...	
50	„ ...	259	4·70	Ulcer extravasation. many nematodes.	F.	S.	1 : 55·10	„ ...	Stomach ulcers and large extravasation.
51	„ 12...	191	0·91	Nematodes ...	F.	V. N.	1 : 209·9	„ ...	
52	„ 15...	653	1·90	Ulcer and nematodes	F.	A.	1 : 343·5	Bamburda village	Pregnant.
53	„ 17...	452	0·50	Nematodes ...	M.	F.	1 : 904	Railway crossing.	
54	October 1	150	0·25	Petechiæ ...	F.	V. N.	1 : 600	Bamburda village	
55	„ 4...	559	1·15	Healthy liver, full of nematodes.	F.	A.	1 : 486·0	City	
56	„ 7...	963	2·60	Nematodes ...	M.	A.	1 : 370·4	Bamburda village	
57	„ 9...	352	0·70	Healthy... ...	M.	A.	1 : 502·8	Bombay ...	
58	„ ...	193	0·70	Nematodes, ulcer.	F.	A.	1 : 275·7	„ ...	Pregnant. One young one ; body weight 8·5.
59	„ ...	342	0·85	Healthy	M.	A.	1 : 402·3	„	
60	„ ...	296	1·70	Nematodes ...	M.	A.	1 : 115·2	„	
61	„ 12...	412	1·25	„ ...	F.	V. N.	1 : 329·6	City	
62	„ ...	225	0·90	„ ...	F.	N.	1 : 250·0	Bombay.	
63	„ ...	205	2·25	Extravasation ...	M.	A.	1 : 91·1	„	
64	„ ...	227	1·00	Ulcer	M.	A.	1 : 227·0	„	
65	„ 19...	476	1·50	Nematodes, ulcer.	M.	A.	1 : 317·3	City.	
66	„ 21..	742	1·70	Nematodes ...	F.	A.	1 : 436·4	Bamburda.	
67	„ 24...	750	1·90	Nematodes, ulcers	F.	A.	1 : 394·2	„	
68	„ ..	249	1·60	Nematodes ...	F.	N.	1 : 155·6	Bombay	
69	„ ...	278	1·20	Healthy... ...	M.	A.	1 : 231·6	„	
70	„ ...	321	2·32	Nematodes, petechiæ	M.	F.	1 : 138·3	„	
71	„ ...	216	0·95	Healthy... ...	F.	F.	1 : 227·3	Bamburda	
72	„ 25 .	220	1·20	Nematodes ...	F.	A.	1 : 191·6	City	
73	„ 29...	909	1·30	Healthy... ...	F.	A.	1 : 698·4	„	
74	„ ..	330	0·30	Nematodes ...	F.	A.	1 :1100 0	„	
75	„ 30...	319	0·95	Ulcers	M.	A.	1 : 335·7	Bombay.	
76	„ ...	605	1·30	Healthy... ...	F.	A.	1 : 465·3	„	
77	„ ...	318	1·45	„	M.	A.	1 : 219·3	„	
78	„ ...	269	0·70	Nematodes ...	M.	A.	1 : 384·2	„	
79	November 2 ..	553	1·25	Numerous nematodes, stomach quite full.	F.	A.	1 : 442·5	Camp.	
80	„ ...	192	1·30	Petechiæ ...	M.	S.	1 : 147·7	Bamburda.	
81	„ 4..	224	0·40	Healthy... ...	M.	N.	1 : 560·0	Bamburda village	
82	„ 14...	39	0·10	„	F.	A.	1 : 390·0	„	
83	„ 18...	659	2·65	Few nematodes...	M.	A.	1 : 248·6	Camp.	
84	„ 20...	903	1·30	Nematodes ...	F.	A.	1 : 850·0	.....	
85	„ 25...	1105	2·00	Ulcers and worms.	M.	A.	1 : 552·5	Bamburda.	
86	December ...	545	0·95	Nematodes and ulcer.	F.	A.	1 : 573·6	City.	
87	.....	589	27·00	„ ...	F.	A.	1 : 21·81	Club.	

No.	Date.	Body Weight.	Spleen Weight.	Liver Weight.	Stomach.	Sex.	Hæmatozoa.	Ratio of Spleen to Body Weight.	Locality.	Ratio of Liver to Body Weight.	Remarks.
	1894.	Grammes.	Grammes.	Grammes.							
88	December 9...	202	1·40	...	Healthy ...	M.	S.	1 : 144·2	City	...	Donkey inoculated 3·25 c.c.
89	„ 15...	7·5	2·10	...	Nematodes ...	F.	A.	1 : 350·0	„	...	White corpuscles increased.
90	„ 16...	805	2·00	...	„ ...	F.	A.	1 : 402·5	„	...	
91	„ 17...	587	4·60	...	„ ...	M.	A.	1 : 127·6	„	...	
92	„ 19...	615	1·15	...	„ ...	F.	A.	1 : 534·7	Bamburda Village.	...	
93	„ 21...	156	0·30	...	„ ...	F.	A.	...	Camp... ...	...	
94	„ 26...	710	2·10	...	Healthy ...	F.	A.	1 : 388·0	„	...	Liver nematodes.
95	„ 27...	540	2·00	20·00	Nematodes ...	M.	A.	1 : 270·0	Jungli ...	1 : 27	„ „
96	„ 28...	820	4·30	33·00	„ ...	M.	A.	1 : 190·7	Camp... ...	1 : 35	„ „
97	„ 29...	837	2·20	...	Healthy ...	F.	A.	1 : 377·7	„	...	
98	„ 30...	537	5·70	...	Nematodes ...	M.	S.	1 : 94·2	Bamburda Village.	...	Liver nematodes.
99	„ ...	484	1·00	...	Healthy ...	F.	A.	1 : 484·0	„ ...	...	„ „
100	„ 31...	935	6·40	40·00	Nematodes ...	M.	A.	1 : 146·0	„ ...	...	
	1895.										
101	January 1...	417	1·00	17·50	Healthy ...	F.	A.	1 : 417·0	City	1 : 23·8	
102	„ 2...	572	2·75	...	„ ...	M.	A.	1 : 208·0	„	...	Liver diseased.
103	„ 3...	530	2·60	...	„ ...	F.	A.	1 : 203·8	„	...	Liver soft and friable.
104	„ ...	495	2·25	...	Nematodes ...	F.	V.N.	1 : 220·0	„	...	
105	„ 6...	170	0·50	...	Healthy ...	M.	A.	1 : 340·0	„	...	Liver healthy.
106	„ 7...	346	0·75	...	Nematodes ...	F.	A.	1 : 461·0	„	...	„ diseased.
107	„ 9...	215	0·65	13·45	„ ...	F.	F.	1 : 453·8	Camp... ...	1 : 21·9	
108	„ 11...	366	1·35	20·45	Healthy ...	M.	A.	1 : 271·1	City	1 : 17·8	
109	„ 13...	83	0·85	6·80	„ ...	M.	S.	1 : 97·6	„	1 : 12·2	Liver healthy.
110	„ ...	408	1·48	19·40	„ ...	F.	V.N.	1 : 275·6	„	1 : 21·0	„ diseased.
111	„ 17...	128	0·70	7·22	„ ...	M.	S. Teeming.	1 : 183·0	Bamburda Village.	1 : 17·7	„ healthy.
112	„ ...	142	0·60	10·70	„ ...	M.	S.	1 : 236·0	„ ...	1 : 13·2	„ „
113	„ 18...	230	1·12	13·00	„ ...	F.	S.	1 : 205·3	City	1 : 17·7	„ diseased.
114	„ 20...	624	2·05	15·60	Few small nematodes.	M.	A.	1 : 304·3	„	1 : 33·5	„ healthy.
115	„ 21...	567	2·30	18·50	Healthy ...	F.	A.	1 : 246·5	„	1 : 30·6	„ Tape worm.
116	„ ...	900	2·90	37·00	Nematodes, ulcer.	M.	A.	1 : 310·3	„	1 : 24·3	„ diseased.
117	„ 22...	555	1·70	20·9	Nematodes ...	F.	V.N.	1 : 326·4	„	1 : 26·5	Liver diseased.
118	„ ...	211	0·70	9·90	Healthy ...	M.	V.N.	1 : 301·4	Camp... ...	1 : 21·3	„ „ slightly.
119	„ 24...	386	1·37	20·57	„ ...	F.	A.	1 : 281·7	„	1 : 18·7	„ „
120	„ 25...	837	3·00	26·54	Nematodes ...	F.	N.	1 : 279·0	„	1 : 31·1	„ „
121	„ 27...	584	3·45	28·25	„ ...	F.	A.	1 : 69·2	„	1 : 20·6	„ „
122	„ ...	559	2·95	31·70	„ ...	M.	A.	1 : 189·0	„	1 : 17·6	„ „
123	„ 28...	772	4·40	37·60	„ ...	M.	F.	1 : 175·4	„	1 : 20·5	„ „
124	February 12...	795	4·50	34·75	„ ...	F.	A.	1 : 176·6	„	1 : 22·8	Liver diseased, Fœtuses 33·40 grammes.
125	„ 14...	636	4·55	33·00	Healthy ...	F.	A.	1 : 139·7	City	1 : 19·2	
126	„ ...	246	1·57	18·07	„ ...	M.	V.N.	1 : 156·6	Camp... ...	1 : 13·6	
127	„ 15...	867	3·40	25·90	Ulcer nematodes.	F.	A.	1 : 255·0	City	1 : 33·4	
128	„ ...	682	2·63	30·22	Healthy ...	M.	A.	1 : 259·3	Camp... ...	1 : 22·5	
129	„ 16...	820	2·05	24·56	Nematodes ...	F.	A.	1 : 400·0	Railway Station.	1 : 33·3	
130	„ 21...	800	2·22	30·10	Full, nematodes.	F.	A.	1 : 360·3	Poona... ...	1 : 26·5	
131	„ 28...	742	2·10	30·90	Healthy ...	F.	A.	1 : 353·3	„	1 : 24·0	Liver tape worms.
132	„ ...	534	1·15	24·90	Nematodes ...	F.	A.	1 : 464·3	„	1 : 21·4	„ „ + nematodes.
133	March 3...	438	1·55	21·50	Ulcer Nematodes.	M.	A.	1 : 282·5	„	1 : 20·3	
134	„ 8...	703	3·15	28·20	Nematodes ...	F.	A.	1 : 223·1	Bamburda Village.	1 : 24·9	
135	„ 9...	511	1·35	18·26	„ ...	F.	A.	1 : 378·5	„ ...	1 : 20·9	Liver tape worms.
136	„ 17...	777	3·47	33·20	Healthy ...	F.	A.	1 : 223·9	„ ...	1 : 23·4	„ 7 „
137	„ 21...	810	4·40	30·00	Nematodes and ulcer.	M.	A.	1 : 184·0	City	1 : 27·0	„ 3 „
138	„ 22...	740	4·90	35·70	Healthy ...	F.	A.	1 : 151·0	„	1 : 20·7	„ 1 „ Fœtuses 4·03
139	„ 23...	541	1·55	19·80	Nematodes ...	M.	F.	1 : 349·0	„	1 : 27·3	„ 1 „
140	„ ...	569	4·85	38·30	Nematodes and ulcers.	F.	A.	1 : 117·3	„	1 : 14·8	„ 23 „
141	„ 25...	142	0·22	4·05	Healthy ...	M.	A.	1 : 645·4	Jungli ..	1 : 35·06	
142	„ ...	714	3·10	35·05	Nematodes ...	F.	A.	1 : 230·3	Bamburda Village.	1 : 20·3	Liver one tape worm.
143	„ 30...	327	0·95	14·77	Healthy ...	M.	V.N.	1 : 344·2	„ ...	1 : 22·14	„ healthy.
144	April 3...	435	1·47	18·25	„ ...	M.	V.N.	1 : 295·9	City	1 : 23·83	
145	„ 4...	695	1·35	29·90	„ ...	F.	A.	1 : 514·8	„	1 : 23·26	Liver 7 Tape worms.
146	„ 6...	292	0·45	6·95	Nematodes ...	F.	V.N.	1 : 648·8	„	1 : 42·01	„ healthy.
147	„ 7..	915	3·95	29·60	„ ...	M.	A.	1 : 231·6	„	1 : 30·91	
148	„ 8 .	450	1·90	18·20	Healthy ...	F.	N.	1 : 236·8	„	1 : 24·72	Liver 2 Tape worms.
149	„ 11 ..	237	0·75	9·50	„ ...	M.	V.N.	1 : 316·0	„	1 : 24·94	„ 12 „
150	„ ...	750	3·85	31·15	„ ...	M.	A.	1 : 194·8	Bamburda Village.	1 : 24·07	„ 1 Tapeworm.

During the ten months the number of Bandicoots examined each month was too small to draw any deductions as to whether there was any increase of the hæmatozoon during the monsoon period of the year.

Table XXXVII.

The following table shows a list of Bandicoots examined from July 1894 to April 1895, together with the results of microscopical examinations of their blood, and the percentage of those in which the hæmatozoon was present and absent, respectively :—

Month.	Absent.	Few.	Numerous.	Very Numerous.	Swarming.	Total.	Percentage.	
							Present.	Absent.
1894.								
July	1	...	1	...	...	2	50·00	50·00
August... ...	32	1	1	...	3	37	13·51	86·48
September ...	10	1	1	1	1	14	28·57	71·42
October ...	19	2	2	2	...	25	24·00	76·00
November ...	5	...	1	...	1	7	28·57	71·42
December ...	13	...	...	...	2	15	13·34	86·66
1895.								
January ...	12	2	1	4	4	23	48·00	52·00
February ...	8	...	...	1	...	9	11·11	88 88
March	9	1	...	1	...	11	18·18	81 81
April	3	...	1	3	...	7	57·14	42·86
Total ...	112	7	8	12	11	150	...	...
Percentage ...	74·66	4·66	5·33	8·00	7·33	100·0	25·33	74·66

The following table however shows the relative number of hæmatozoa in the circulation of all Bandicoots examined :—

Hæmatozoa in blood.	Absent.	Few.	Numerous.	Very Numerous.	Swarming.	Total.	Absent.	Present.
In field of microscope ...	...	1—5	5—20	20—50	Over 50	...	...	...
Number of bandicoots ...	112	7	8	12	11	150	112	38
Percentage ...	74·66	4·66	5·33	8·00	7·33	100·00	74·66	25·33

The observations made during the years 1894 and 1895 confirm those of 1893 with regard to the presence of the *Trypanosoma* in the circulation of young and half-grown animals of this species, and their almost entire absence from full-grown animals examined.

The difficulty experienced in obtaining Bandicoots militated against the attempt on our part to obtain a complete knowledge of the conditions of the blood of these animals, during each month of the year. But it is more than probable, from our present knowledge, that the same changes with regard to the *Trypanosoma* during the dry and wet seasons occur in the circulation of bandicoots as those detailed as observed in the rat.

Several varieties of the *Trypanosoma* have been found in the blood of bandicoots, but they appear to belong to the same species. One variety, however, is worthy of special mention, as it resembles a long narrow leaf in shape somewhat.

Five or six of these animals were kept for some time in separate cages and their blood examined daily with a view to determine the usual length of the paroxysms, &c., but in the two cases given below in each instance, after a few days in captivity, the hæmatozoon gradually diminished in numbers until they disappeared altogether.

Bandicoot II was caught in July 1894. The hæmatozoa were numerous on the first day on which the blood was examined, but gradually decreased in number until none could be discovered ; this condition continued for several weeks, when unluckily it bit through its cage and escaped.

Bandicoot III was caught on August 1st 1894. Microscopical examination of the blood revealed numerous hæmatozoa ; their movements, however, were sluggish and wormlike. This animal was kept in a cage, corn and clean water being supplied twice daily. From the 1st to the 7th August inclusive, the organisms gradually decreased in number, and from the 8th to 26th, on which latter date the bandicoot died, the hæmatozoa were absent from the blood.

In Column III of the following table will be observed how enormously the numbers of hæmatozoa were found to vary in the blood of different bandicoots.

Table XXXVIII.

Showing the number of hæmatozoa, red and white corpuscles in one cubic millimetre of the blood of Bandicoots [*Mus* (*Nesokia*) *giganteus*] :—

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII
Serial number.	Number in Laboratory Case Book.	Hæmatozoa in blood one cubic millimetre.	Number of organisms (abbreviations).	Red corpuscles in blood one cubic millimetre.	White corpuscles in one cubic millimetre.	Ratio white corpuscles to red corpuscles.	Ratio hæmatozoa to red corpuscles.	Body-weight.	Spleen-weight.	Liver-weight.	Ratio spleen-weight to body-weight.	Ratio liver-weight to body-weight.
								Grammes.	Grammes.	Grammes.		
1	123	664	F	6,660,000	12,600	1 : 528	1 : 10,030	772	4·40	77·6	1 : 175	1 : 20·5
2	120	2,400	F	6,200,000	19,400	1 : 319	1 : 2,583	837	3·00	26·9	1 : 279	1 : 31·1
3	117	35,500	S	5,850,000	6,600	1 : 889	1 : 164	555	1·70	20·9	1 : 326	1 : 26·5
4	118	36,000	S	5,400,000	3,600	1 : 1,500	1 : 150	211	0·70	9·9	1 : 301	1 : 21·3
5	112	101,000	T	4,110,000	10,500	1 : 391	1 : 40·7	142	0·60	10·7	1 : 236	1 : 13·2
6	109	293,000	T	7,190,000	12,500	1 : 590	1 : 24·5	83	0·85	6·8	1 : 97·6	1 : 12·2
7	111	349,550	T	5,940,000	32,600	1 : 182	1 : 16·9	128	0·70	7·2	1 : 183	1 : 17·7

SECTION IV.

Precis of Cases of animals inoculated with soiled Bandicoot's Blood.

A.—Result Positive.

Guinea Pig.—Inoculated subcutaneously on August 5th, 1894, with 0·2 c. c. of blood containing swarms of hæmatozoa taken from the heart of Bandicoot No. 4, immediately after death. The period of incubation occupied four days. The hæmatozoon appeared on the 9th of August and was present in the blood during the 10th and 11th, but was absent on the 12th. After the one day intermission it again appeared in the circulation for 24 hours, and then disappeared altogether; for it was not observed, although daily microscopical examinations of the blood were made in the interval between the 14th August and 16th of September, on which latter date the animal succumbed. Temperature record, Appendix page 201.

Autopsy.—No marked pathological changes present. Body weight 194 grammes. Spleen weight 0·2 grammes. Ratio of spleen to body weight 1 : 970.

B.—Results Negative.

Mule III, aged, but in good health, was inoculated subcutaneously on the 16th October 1894 with 1·5 c. c. of blood containing very numerous hæmatozoa taken from the heart of a Bandicoot (No. IV), immediately after death. Swelling appeared at the seat of inoculation on the 17th and gradually increased up to the 19th, then gradually disappeared. The temperature of the animal kept within normal limits between the above date and January 3rd, 1895, a period of 80 days, the blood examined daily always presented a perfectly healthy appearance. The mule was re-inoculated on the latter date with 2·5 c.c. of blood containing very numerous hæmatozoa taken from Bandicoot No. CIV immediately after death. On the 4th a swelling 4×3 inches appeared at the seat of the injection of blood, which disappeared by the 8th. During the following three weeks the animal showed no signs of disease, so on the 22nd January 1895 the mule was inoculated for the third time by making a very small incision in the skin of the mu zzle and placing between the edges of the wound some soiled blood from a Bandicoot containing very numerous hæmatozoa. Thirty-seven days were allowed to elapse, during which time the animal showed no symptoms of Surra and the blood examined daily maintained a healthy condition. It was then decided to inoculate the mule with a slight trace of Surra blood containing hæmatozoa from the horse. Consequently, on February 27th, 1895, a small scratch was made in the skin of the muzzle and trace of soiled blood from Horse CXXV was placed on the surface of the scratch. Slight thickening followed at the seat of the inoculation. The latent period occupied nearly seven days. On April 27th, 1895, chloroform was administered to the mule and death followed. Between the first appearance of the Surra *Trypanosoma* in the blood and death 53 days elapsed, made up of five paroxysms lasting 5, 20, 4, 4 and 6 days, and five intermissions lasting 2, 5, 2, 3 and 2 days respectively.

Autopsy.—Ordinary pathological changes of Surra noted.

Donkey No. IV.—This animal, aged 10 years, height 9½ hands, was in good health and condition. Subcutaneous inoculation was performed at intervals as under, with blood derived from different bandicoots, with a view to produce Surra, but always with negative results.

(i) 12th September 1894, inoculated subcutaneously 0·6 c.c. blood containing very numerous hæmatozoa.

(ii) 9th December 1894, inoculated subcutaneously 3·25 c.c. blood containing swarms of hæmatozoa.

(iii) 15th January 1895, inoculated subcutaneously 2·40 c.c. blood containing swarming hæmatozoa.

(iv) 17th January 1895, inoculated subcutaneously 2·60 c.c. blood containing teeming hæmatozoa.

(v) 22nd January 1895, inoculated subcutaneously on muzzle trace of blood containing very numerous hæmatozoa.

(vi) 3rd April 1895, inoculated subcutaneously 2·0 c.c. blood containing very numerous hæmatozoa.

(vii) 8th April 1895, inoculated subcutaneously 7·5 c.c. blood containing numerous hæmatozoa.

Between the 5th and 6th inoculations after a period of observation the animal was submitted to a course of Iodides of Arsenic and Mercury, with two objects in view: (i) to observe the changes which occurred in the constituents of the urine, during and after the administration of the drug, as also with regard to the corpuscular elements of the blood; (ii) to render the animal, if possible, more susceptible to the organisms of the bandicoot at the succeeding inoculation.

Rabbit No. I.—Inoculated with 0·2 c.c. of blood, containing swarms of hæmatozoon taken from the heart of Bandicoot No. IV immediately after death. Blood examined from August 5th to November 6th, 1894, but no hæmatozoa were found in the blood.

Rabbit No. II.—Inoculated with 0·4 c.c. of blood, taken from the heart of Guinea Pig No. I, immediately after death. Blood microscopically examined from September 15th to November 19th, 1890. No hæmatozoa observed.

Rabbit No. III.—Inoculated with 0·1 c.c. of blood, containing swarms of hæmatozoa, taken from heart of Bandicoot No. XIII, immediately after death. Blood examined from August 15th to October 25th, 1894, on which latter date the animal succumbed. No hæmatozoa. A minute spirillum was observed.

Rabbit No. IV.—Inoculated with 0·1 c.c. of blood, containing swarms of hæmatozoa, taken from the heart of Bandicoot No. XIII, immediately after death. Blood examined from August 15th to September 23rd, 1894, when death occurred. No hæmatozoa, but spirillum found. *Vide* Appendices page 203.

SECTION V.

Pathological Changes.

The *post mortem* examinations of bandicoots proved of great interest. Nematode worms varying in numbers and dimensions ($\frac{1}{2}$ to 5 inches in length) were found in the stomachs of these animals, in many instances completely distending the organs. In a total of 150 animals examined, nematodes were found in 90 or 60 per cent.

The livers of these animals were also the seat of extensive changes, due to the presence of vast numbers of nematode eggs (*Trichocephalus dispar*), some of which mature *in situ*, and frequently the young worms escape into the peritoneal cavity.

The chief pathological changes observed were ulceration (sometimes extensive) of the villous portion of the stomach, and as an effect of the former, the formation of diverticula, the walls of the sac being formed of thickened peritoneum, extravasations of blood under the submucous tissues; enlarged spleen—4 or 5 times the normal size—and less frequently abscess of liver, spleen and subcutaneous tissues.

As in the case of pregnant rats, so in that of pregnant bandicoots, although the *Trypanosoma* was present in vast numbers in the blood of the mother, in no instance has it been discovered in the circulation of the fœtus.

Table XXXIX.

Showing the total weight in grammes of the Body weights and Spleen weights of Bandicoots examined in the blood of which the Trypanosoma was present or absent during ten months, together with the Ratio of Spleen to Body-weight.

Month, year.	Hæmatozoa Present.			Hæmatozoa Absent.			Number of Bandicoots.	
	Body-weight.	Spleen-weight.	Ratio Body-weight to Spleen-weight.	Body-weight.	Spleen-weight.	Ratio Body-weight to Spleen weight.	Present.	Absent.
1894.	Grammes.	Grammes		Grammes	Grammes			
July	238·0	0·63	1 : 377	460·0	1·71	1 : 269	1	1
August	1,059·0	7·42	1 : 143	12,533·3	42·86	1 : 292	5	32
September	1,140·0	6·74	1 : 167	3,569·0	17·46	1 : 204	4	10
October	1,573·0	7·27	1 : 216	8,353·0	24·45	1 : 342	6	19
November	416·0	1·70	1 : 245	3,559·0	7·30	1 : 487	2	5
December	739·0	7·10	1 : 105	8,358·0	31·10	1 : 268	2	13

Month, Year.	Hæmatozoa Present.			Hæmatozoa Absent.			Number of Bandicoots.	
	Body-weight.	Spleen-weight.	Ratio Body-weight to Spleen-weight.	Body-weight.	Spleen-weight.	Ratio Body-weight to Spleen-weight.	Present.	Absent.
1895.								
January	4,156·0	17·45	1:238	6,021·0	23·97	1:251	11	12
February	246·0	1 57	1:157	5,876 0	22·60	1:260	1	8
March	868·0	2·50	1:347	5,404·0	26·99	1:200	2	9
April	1,414·0	4·57	1:309	2,360·0	9·15	1:258	4	3
Total ...	11,849·0	56·95	1:208	56,493	207·59	1:272	38	112
							150	

Table XL.

Showing the total Body-weight and weight of the Liver of Bandicoots examined month by month in the blood of which the Trypanosoma was present or absent, together with the Ratio of Liver to Body-weight.

Month, Year.	Hæmatozoa Present.			Hæmatozoa Absent.			Number of Badicoots.		Total.
	Body-weight.	Liver-weight.	Ratio Liver to Body-weight.	Body-weight.	Liver-weight.	Ratio Liver to Body-weight.	Present.	Absent.	
1894.									
December	...	...	...	2,295	93·00	1:24·7	...	3	3
1895.									
January	3,581·0	165·51	1:21·6	4,517	169·00	1:26·7	10	7	17
February	246·0	18·07	1:13·6	5,876	234·33	1:25·0	1	8	9
March	868·0	34·57	1:25·1	5,404	244·26	1:22·1	2	9	11
April	1,177·0	43·40	1:27·1	2,597	100·15	1:25·3	4	3	7
Total ...	5,872·0	261·55	1:22·5	20,689·0	840·74	1:24·6	17	30	47

As at all autopsies on large and small animals, the principal organs are weighed and a register kept, the above tables have been made in order to observe the ratio of spleen to body-weight and liver to body-weight in animals in which the hæmatozoa were present or absent. Massing the returns under their respective headings, we find that in the case of the former the ratio of spleen to body-weight is as 1 : 208; while in the case of the latter, it is 1 : 272. That is, the average weight of the spleen in bandicoots which have the *Trypanosoma* present in their circulation is 23·53 per cent. heavier than in animals of the same species whose blood is healthy. In individual cases the spleen has been found to be 9 or 10 times the normal size.

For a shorter period, the statistics with regard to the ratio of liver to body-weight have been furnished for 47 bandicoots in which the hæmatozoa were present in 17, and absent in 30 animals. In the former the ratio was as 1 : 22·5, and in the latter as 1 : 24·6, or a difference of 8·54 per cent.

SECTION VI.

Injection of Bandicoot Serum into small animals with a view to producing a resistance to the Inoculated Trypanosoma of Horse Surra.

Experiments were conducted with a view to determine whether repeated injections of bandicoot serum subcutaneously would have any deterrent effect upon the presence and growth of the hæmatozoon of Surra in the circulation of Rabbits and Guinea Pigs. For this purpose small animals were inocu-

lated with the soiled blood of Surra horses, and on the day following inoculation, bandicoot serum was subcutaneously injected, and the doses repeated at varying intervals of 24 to 72 hours. The serum was collected from old and full-grown bandicoots, as it was recognised that during their life these animals pass through repeated periods, during which several varieties of hæmatozoa are present in their circulation. Consequently full-grown bandicoots with hæmatozoa were kept under observation until the organisms had disappeared from their blood. They were then killed, and the blood collected, the serum being allowed to separate. The following cases in the Rabbit and Guinea Pig are typical of the results produced:—

Rabbit.—This animal was subcutaneously inoculated on the 23rd December 1894 with 0·6 c.c. of blood containing very numerous hæmatozoa taken from the jugular vein of Horse No. CXXIII. The injections of bandicoot serum were commenced on the following day.

Table XLI.

Showing the date, temperature, and amount of Serum administered, together with details with regard to the microscopical examination of the blood.

Rabbit No. I.

Date.	How administered.	Quantity of Serum injected c.c.	Temperature. A.M.	Temperature. P.M.	Hæmatozoa.	Remarks.
1894.						
December 23 ...	Inoculated with blood from Surra Horse No. CXXIII.	...	38·2	39·2	Absent.	
„ 24 ...	Subcutaneous injection of Bandicoot Serum.	2·24	38·2	39·4	„	
„ 25 ...	Do. do. ..	0·48	38·5	39·8	„	
„ 26 ...	Do. do. ...	2·24	39·4	39·9	„	
„ 27 ...	Do. do. ...	...	40·4	41·1	„	
„ 28 ...	Do. do. ...	...	40·6	40·4	„	
„ 29 ...	Do. do. ...	2·48	40·0	40·6	„	
„ 30 ...	Do. do. ...	...	40·0	39·9	„	
„ 31 ...	Do. do. ...	6·20	40·2	40·2	„	
1895.						
January 1 ...	Do. do. ...	3·75	40·0	40·7	„	
„ 2 ...	Do. do. ...	1·20	39·8	41·0	„	
„ 3 ...	Do. do. ...	...	40·2	40·2	„	
„ 4 ...	Do. do. ...	...	39·7	40·2	„	
„ 5 ..	Do. do. ...	...	40·2	41·2	„	
„ 6 ...	Do. do. ...	...	40·0	41·1	„	
„ 7 ...	Do. do. ...	...	40·2	40·6	„	
„ 8 ...	Do. do. ...	2·20	40·2	40·6	„	
„ 9 ...		Nil	40·0	40·0	„	
„ 10 ...		„	39·6	40·2	„	
„ 11 ...		„	40·0	39·6	„	
„ 12 ...		„	39·9	40·0	„	
„ 13 ...		„	39·0	39·6	„	White corpuscles increased in number.
„ 14 ...		„	39·0	39·4	„	Ditto.
„ 15 ...		„	39·2	39·7	„	Ditto.
„ 16 ...		„	40·0	40·2	„	Ditto.
„ 17 ...		„	40·2	40·6	„	Ditto.
„ 18 ...		„	39·8	40·2	„	Ditto.
„ 19 ..		„	39·2	40·0	„	Ditto.
„ 20 ...		„	39·0	40·2	Few	3 hæmatozoa in one cover-glass specimen of blood.
„ 21 ...		„	38·3	39·8	Few	1,000 hæmatozoa in do. do.

Guinea Pig No. I was inoculated subcutaneously on the 23rd December 1894 with 0·48 c.c. of blood containing very numerous hæmatozoa taken from the jugular vein of Horse No. CXXIII. The injections of serum were commenced on the 24th December and were continued—*vide* Table No. XLII.

Table XLII.

Showing the date, temperature, and amount of Serum administered, together with details with regard to the microscopical examination of the blood.

Guinea Pig.

Date.	How administered.	Quantity of Serum injected c.c.	Temperature. A.M.	Temperature. P.M.	Hæmatozoa.	Remarks.
1894.						
December 23 ...	Inoculated 0·48 c.c. Horse Surra blood.	...	...	...	Absent.	
„ 24 ...	Subcutaneous injection of Bandicoot Serum.	1·52	...	38·8	„	
„ 25 ..	Do. do. ...	0·80	38·0	38·6	„	
„ 26 ...	Do. do. ...	1·84	37·8	38·5	„	
„ 27 ...	Do. do. ...	...	38·4	39·6	„	
„ 28 ...	Do. do. ...	...	37·6	39·6	Few	1 hæmatozoon in cover-glass specimen of blood.
„ 29 ..	Do. do. ...	2·48	37·4	40·2	„	White corpuscles increased in number.
„ 30 ...	Do. do. ...	...	38·8	40·2	„	Ditto.
„ 31 ...	Do. do. ...	2·40	40·0	39·8	„	Ditto.
1895.						
January 1 ...	Do. do. ...	2·40	38·0	40·6	„	
„ 2 ...	Do. do. ...	1·25	38·4	40·3	Numerous	12,000 hæmatozoa in cover-glass.
„ 3 ...	Do. do. ...	...	38·4	39·6	„	14,000 ditto.
„ 4 ...	Do. do. ...	...	37·4	40·1	„	14,000 ditto.
„ 5 ..	Do. do. ...	...	37·4	39·8	„	
„ 6 ...	Do. do. ...	...	38·0	40·2	„	
„ 7 ...	Do. do. ...	...	38·6	40·0	„	
„ 8 ...	Do. do. ...	0·30	38·4	40·3	Few	
„ 9 ...		Nil	38·7	39·8	„	
„ 10 ..		„	37·6	40·4	„	
„ 11 ...		„	37·8	39·5	„	
„ 12 ...		„	38·6	39·8	„	
„ 13 ...		„	37·4	39·4	„	
„ 14 ...		„	38·0	38·8	„	
„ 15 ...		„	37·8	39·2	„	
„ 16 ...		„	37·4	39·6	„	
„ 17 ..	Death during the night ...	„	...	...	„	

With reference to the injection of serum it will be as well to mention that according to Table XI, Vol. I, Surra Report, "showing the latent period of Surra ascertained experimentally in different animals," the period of incubation when inoculated from soiled Horse Surra blood taken during life and containing numerous hæmatozoa, in two instances in the Rabbit, occupied 5 and 9 days respectively, giving an average of 7 days, while in three Guinea Pigs the latent period occupied 11, 9 and 7 days respectively, or an average of 9 days. In the above tables it will be seen that in the case of the Guinea Pig the hæmatozoon appeared on the 6th day or about 120 hours after inoculation, when a total of 4·16 c.c. of serum had been injected, whereas in the control animals noted the average period was 216 hours. It would therefore appear that in the case of the Guinea Pig the effect produced by the serum was rather to shorten the latent period by five days or to render the animal more suceptible to the action of the *Trypanosoma*. The most marked effect produced was upon the course of the disease, for instead of paroxysms and intermissions taking place, the organism after its first appearance in the blood remained present until death occurred. The hæmatozoa present were however very small in number and never attained to anything like the proportion usually noticed in Surra in the Guinea Pig.

The effect produced in the case of the Rabbit was essentially different. We have observed that the period of incubation occupied in the control animals of the same species inoculated with Horse Surra blood containing hæmatozoa, was on an average 7 days duration. A total of 20·79 c.c. of Bandicoot serum was injected subcutaneously during this experiment on the 2nd, 3rd, 4th, 7th, 9th, 10th, 11th and 17th days after the inoculation with Surra blood, the only effect produced being an increase in the number of white cells in the blood on the 7th and 8th days and again from the 23rd to the 26th days inclusive. During the last 19 days of the life of the animal only one injection of serum was made. Forty-eight hours before death occurred, the 29th day after inoculation, the Trypanosoma made its appearance in the blood in very small numbers, but on the day of death there was a further increase. The result therefore of the serum injection in the case of the Rabbit must be looked upon as a distinct success, for the period of incubation instead of occupying 7 took 29 days; a retardation of 22 days.

In this case if further injections of serum had been administered, a prolongation of the latent period might have occurred or even a cure might have been established. The difficulty of obtaining bandicoots was considerable, and out of 15 caught in December, 1894, only two presented the hæmatozoon in their circulation :—

TABLE XLIII.

Experimental cases.

Appendix Number.	Number.	Kind of Animal inoculated.	Fluid used for the purpose of inoculation.	Quantity of fluid used for inoculation.	From what Animal fluid used was taken.	Date of Inoculation.	How administered.	Inoculation with fluid taken *ante mortem*.	Number of Hæmatozoa present in fluid *ante mortem*.	Inoculation with fluid taken *post mortem*.	Number of hours fluid taken *post mortem*.	Number of Hæmatozoa in fluid taken *post mortem*.	Result of Inoculation, Positive or Negative.	Date of first appearance of Hæmatozoon in the blood.	Number of days after inoculation 1st appearance of Hæmatozoa in the blood.	Result of Inoculation.	Date of death.	Days between inoculation and death.	Remarks.
I ...	I...	Guinea Pig	Blood .	0·2 c.c.	Bandicoot IV.	5th August 1894.	Subcutaneous inoculation.	...	...	P.M.	Immediately.	S.	P.	9th August 1894.	4	Death	15th September 1894.	41	
	IV...	Donkey ...	,, ...	0·6 c.c. 3·25 c.c. 2·40 c.c. 2·60 c.c.	Bandicoots.	12th September 1894. 9th December 1894. 15th January 1894. 17th January 1895.	Do. ...	...	...	P.M.	Do. ...	V.N S. S. S.	N.	...	...	...	.....	...	
	III...	Mule ...	,, ...	2·5 c.c. 2.5 c.c.	,, ...	3rd January 1895. 22nd January 1895.	Do. ...	...	...	P.M.	Do. ...	V.N V.N	N.	...	...	...	.....	...	
	I...	Rabbit ...	,, ...	0·2 c.c.	,, IV.	5th August 1894.	Do. ...	...	...	P.M.	Do. ...	S.	N.	...	...	...	.....	...	
	I...	,, ...	,, ...	0·1 c.c.	,, XIII.	15th August 1894.	Do. ...	...	...	P.M.	Do. ...	S.	N.	...	...	Death	23rd September 1894.	...	Spirillum.
	II...	,, ...	,, ...	0·1 c.c.	,, XIII.	Do. ...	Do. ...	...	...	P.M.	Do. ...	S.	N.	...	...	Do.	25th October 1894.	...	Do.
	I...	Guinea Pig.	,, ...	0·1 c.c	,, XIII.	Do. ...	Do. ...	...	...	P.M.	Do. ...	S.	N.	...	...	Do.	10th September 1894.	...	Do.
	III...	Rabbit ...	,, ...	0·3 c.c.	Rabbit I.	23rd September 1894.	Do. ...	...	...	P.M.	Do. ...	A.	N.	...	...	Do.	25th October 1894.	...	Do.
	IV...	,, ...	,, ...	0·2 c.c.	Guinea Pig I.	10th September 1894.	Do. ...	...	...	P.M.	Do. ...	A.	N.	...	...	Do.	20th October 1894.	...	Do.
	V...	,, ...	,, ...	0·2 c.c.	,, ...	Do. ...	Do. ...	...	...	P.M.	Do. ...	A.	N.	...	...	Do.	17th October 1894.	...	Do.
	II...	Guinea Pig.	,, ...	0·2 c.c.	,, ...	Do. ...	Do. ...	...	...	P.M.	Do. ...	A.	N.	...	...	Do.	3rd October 1894.	...	Do.
	II...	Rabbit ...	,, ...	0·4 c.c.	, ...	15th September 1894.	Do. ...	...	...	P.M.	Do. ...	A.	N.	...	...	...	.....	...	

SECTION VII.

SMALL ANIMALS INOCULATED WITH BLOOD FROM THE BANDICOOT CONTAINING A MINUTE SPIRILLUM.

The blood of the majority of Bandicoots caught in Poona was found to contain an exceedingly minute spirillum during the rainy season, even when the *Trypanosoma* was present in the circulation. Rabbits and Guinea Pigs inoculated subcutaneously with blood containing this organism, contracted the disease, and death resulted in the great majority of cases. This spirillum is exceedingly small, and attention was first called to it in the blood of a Bandicoot, as the blood corpuscles presented an irregular movement, and occasionally minute moving specks were visible in the clear serum spaces between the corpuscles. Never more than five spirilla were observed in a field at one time. Small quantities of Bandicoot blood were injected subcutaneously into Rabbits and Guinea Pigs. The latent period in Rabbits was in five instances 35, 16, 16, 20 and 14 days respectively. The period taken up between the first appearance of the spirillum in the blood and death was occupied in the case of the Rabbits by paroxysms during which the organism was present, and by intermissions during which it was absent from the blood. The former varied in length from 1 to 16 days, and the latter from 1 to 17 days. The animals lived from 16 to 37 days. The latent period in Guinea Pigs averaged 24·5 days, and the animals died on the day that the spirillum made its appearance in the blood.

TABLE XLIV.

Showing the number of Paroxysms and Intermissions which occurred in the course of each case, together with their duration, maximum and minimum temperatures, and the maximum number of Spirilla present during the former.

Number.	Animals.	Fluid used.	Quantity used.	Fluid taken from what animal.	A. M. or P. M.	Date of Inoculation.	How administered.	Latent Period.		Spirillum.		Paroxysm I.			Intermission I.		Paroxysm II.			Intermission II.		Paroxysm III.			Intermission III.	
								Length of days.	Maximum and Minimum Temperature °C.	Date of first appearance.	Temperature °C. at the time of first appearance.	Length in days.	Maximum and Minimum Temperature °C.	Maximum number of Spirilla.	Length in days.	Maximum and Minimum Temperature °C.	Length in days.	Maximum and Minimum Temperature °C.	Maximum number of Spirilla.	Length in days.	Maximum and Minimum Temperature °C.	Length in days.	Maximum and Minimum Temperature °C.	Maximum number of Spirilla.	Length in days.	Maximum and Minimum Temperature °C.
			C. C.																							
1	Rabbit III ...	Blood ...	0·1	Bandicoot No. XIII.	Immediately after death.	15 Aug. 94	Subcutaneously.	35	41·2 38·8	19 Sep. 94	39·6	3	39·7 38·8 F.		14	40·0 38·8	3	39·5 38·8 F.		17	40·2 39·0	Death			...	...
2	Rabbit IV ...	„ ...	0·1	Do. ...	Do. ...	15 Aug. 94	„ ...	16	40·4 38·7	30 Aug. 94	39·8	2	41·2 39·6 F.		11	40·7 39·1	8	40·6 38·8 F.		1	39·8 38·8	1	39·6 39·0 F.		1	39·6 38·5 Death.
3	Rabbit I...	„ ...	0·3	Bandicoot No. I.	Do. ...	23 Sep. 94	„ ...	16	41·4 39·1	9 Oct. 94	39·2	16	41·6 38·4 F.		Death.	...	...	...	...	...	...	...	...	...	...	...
4	Rabbit II ...	„ ...	0·2	Guinea Pig No. I.	Do. ...	10 Sep. 94	„ ...	20	41·2 39·0	30 Sep. 94	39·1	8	40·6 38·4 F.		1	39·4 39·0 IV.	1	39·2 38·9 F.		2	39·8 38·6	2	39·8 38·5 F.		1	39·4 39·0
		...	...	.....	...	...	...	...	...	...	...	2	39·8 39·1 F.		3	40·0 38·6 IV.	Death.	...	...	...	...	...	...	...	...	...	...
5	Rabbit III ...	...	0·2	Do. ..	Do. ...	10 Sep. 94	„ ...	14	40·8 38·8	24 Sep. 94	39·4	2	40·2 39·4 F.		4	40·1 39·0	1	40·0 39·3 F.		1	40·0 39·8	6	40·6 39·1 F.		10	40·6 36·1 Death.
6	Guinea Pig I ...	„ ...	0·2	Do. ...	Do. ...	10 Sep. 94	„ ...	23	40·0 36·9	3 Oct. 94	35·0	1	35·0 F.		Death.	...	...	...	...	...	...	...	...	...	...	...
7	Do. II ...	„ ...	0·1	Bandicoot No. XIII.	Do. ...	15 Aug. 94	„ ...	26	40·2 37·0	10 Sep. 94	35·4	1	35·4 F.		Death.	...	...	...	...	...	...	...	...	...	...	...

PART V.

SURRA AS OBSERVED IN SPONTANEOUS CASES AND AFTER INOCULATION IN THE BANDICOTE.

For a number of years past, imported English dogs, especially Fox-hounds and Fox-terriers, have been found to contract disease and succumb to it, during the first twelve months' residence in this country. The island of Bombay and that portion of the Presidency below the Ghâts has proved a hot-bed of this disease, but other localities inland have not been free, for at Poona, elevation 1,849 ft., Mhow, 2,019 ft., and Ootacamund, at an elevation of 8,000 feet, several severe epidemics among hounds have occurred.

SECTION I.

History of previous outbreaks of spontaneous or acquired Surra.

The first records of heavy mortality in imported Fox-hounds are those of the Ootacamund Kennels in 1869-70. The chief symptoms then noticed were—much distress in breathing and opacity of the corneæ in some cases. From 1870 to 1883 there was no mortality in the Madras Pack. But in 1884 the Hunt imported ten couples from England, obtained three from His Highness the Mahárája of Mysore, and with five couples of old hounds, possessed in all eighteen couples at the beginning of June. On the 8th June one hound was noticed to be ailing and presented constant discharge from the nose, swelling of the throat, &c. This animal succumbed after several weeks, during which time it lost flesh and became considerably emaciated. At a later period a regular epidemic ensued, and in all fourteen couples died within three months. The most marked symptoms being—fever, increased lachrymation, swelling and œdema of the head, throat, limbs and under-surface of the abdomen; a late symptom was opacity of one or both corneæ. After this loss, the Ootacamund Kennels were rebuilt on a different site, and much time and money expended over the welfare of the hounds. Up to this time no diagnosis had been made as to the nature of the disease.*

The history of the Bombay Pack, since 1890, was as follows:—Mr. W. H. Buckland, M.F.H., a lover of animals, lived out at Bandora, some ten miles from the city, where the Kennels were situated. In October of the above year, three of the Master's Arab Horses died of Surra, and later in the season a number of the hounds succumbed to a lingering disease, of which the chief symptoms were fever and progressive emaciation. On the 19th November 1892, a fresh pack of English hounds arrived in Bombay, and were placed in the Bandora Kennels, and given three weeks to recuperate after their voyage. Hunting commenced on the 30th November 1892, and was continued up to the 15th March 1893. Up to the middle of February, the weather was cool and pleasant in the early mornings, temperature between 56° to 60° F.

The first hound to be taken ill was "Noble" on the 11th December 1892. This animal, on several occasions, arrived back at the Kennels, gorged with carrion, and suffered from paroxysmal fever, &c. It succumbed on the 10th January 1893. "Nimrod," last hunting day, 11th December, was ill for several weeks with high fever, swelling of the limbs and under the chest, eventually became blind. Death on 16th February 1893. The following table will show the fate of the hounds, all of which succumbed to similar symptoms:—

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*Under the heading *Madras Hounds—A mysterious disease*—a short paragraph appeared in the "Morning Post," on December 14th, 1897. According to this correspondent, "the Madras Hunt had met with a sad misfortune, for the whole of the fine pack of hounds recently imported has, with the exception of a solitary hound, succumbed to an insidious disease, the nature of which is a mystery." On seeing the above, I communicated with the M. F. H. asking if he would kindly give me further details, for as the hounds suffered from 'Surra' during 1884, perhaps the present outbreak might be due to the same cause. In answer to my letter, the M. F. H. kindly forwarded me the following details.

On the 8th October 1897, five hounds were received from Mysore, and on the 14th of the same month 25 hounds arrived from England, another following on the 31st. The first animal to succumb was a Mysore hound on the 23rd October, fifteen days after its arrival in Madras. On the 1st November two hounds died, a Mysore and an English imported dog, 24 and 18 days after their respective arrivals. Between the 1st November and 9th December, both dates inclusive, 28 hounds died, including the three animals left from the Mysore lot and 25 English.

According to notes kindly supplied by Veterinary Captain E. H. Hazelton, the duration of the disease, in each case, was about 14 days. The temperature, taken three times daily, in nearly every case, reached 105°F. and in no one did it ever fall to normal or nearly so. No opacity of the cornea, conjunctival petechiæ, swellings of limbs or œdema of abdomen or chest were observed. The symptoms noted were those of continued fever, with lung complications. The blood was carefully examined microscopically, during life and after death in the majority of the cases, but no organisms were observed.

The *Autopsies* were conducted by Surgeon Captain Giffard, to whom I am indebted for the following notes:—

The *post mortem* appearances were practically identical in all cases and were:—"Enormous enlargement of the spleen (3 times natural size) but no hæmorrhages. Tissues firm and dark coloured. *Lungs* presented numerous small hæmorrhages, and in those cases in which the animal succumbed to the disease and were not destroyed, small septic abscesses were discovered on section at the seat of the extravasations. The intestines were quite empty and contracted, but no pathological changes were found."

The symptoms, therefore, were continuous high fever, anorexia, rapid emaciation, accelerated and panting breathing, together with staggering gait towards the end of the case. Nothing abnormal found in the blood on microscopical examination.

A similar disease carried off some hounds in the Bombay Pack in 1891, and in the Poona Pack in 1894.

TABLE XLV.

Showing certain details concerning a number of hounds which contracted Surra at and around Bandora during the commencement of 1893.

Number.	Name.	Noticed to be ailing.	Death.	Days.	Remarks.
1	Noble	11th Decr. 1892...	10th Jan. 1893...	31	Arrived after hunting gorged with carrion.
2	Nimrod	Do. ...	16th Feb. 1893 ...	66	Became blind late in case.
3	Ruler	7th Feb. 1893...	Do. ...	10	
4	Wanderer	19th Feb. 1893...	26th Feb. 1893 ...	8	
5	Bedford	22nd Feb. 1893...	10th Mar. 1893...	17	
6	Traveller	23rd Feb. 1893...	4th do. ...	10	
7	Render	2nd Mar. 1893...	16th do. ...	15	12th March, going blind.
8	Viner	Do. ...	26th do. ...	25	Do. almost blind. Shot.
9	Finder	15th Mar. 1893...	30th do. ...	16	20th March almost blind; 26th quite blind. Shot.
10	Marplot	Do. ...	27th do. ...	13	25th March, quite blind.
11	Gaylad	16th Mar. 1893...	23rd do. ...	8	Shot.
12	Cardinal	Do. ...	24th do. ...	9	
13	Denmark	20th Mar. 1893...	1st April 1893...	13	30th March, going blind. Shot.
14	Brusher	1st Mar. 1893...	12th Mar. 1893...	12	These five animals were bitten by a hyæna, on the 8th January 1893.
15	Vulcan	16th Mar. 1893...	1st April 1893...	17	28th March, blind. Shot.
16	Hotspur	15th Mar. 1893...	30th Mar. 1893...	16	20th March, blind. Shot.
17	Dester	18th Mar. 1893...	16th April 1893...	30	
18	Mike (Fox-terrier) ...	20th Mar. 1893...	9th do. ...	21	26th March, high fever, breathing difficult, nearly blind.

Five dogs (four hounds and a fox-terrier) were bitten by a hyæna, during a run on the 8th January 1893. All the five went blind between the 7th and 26th March (the 58th and 77th days), and their several deaths took place between the 12th March and 16th April (63rd to 93th day following the bite). Although the huntsman thought the hyæna bites of some importance, there is no doubt, the deaths were *post hoc* and not *propter hoc*. The animals hunted were foxes, jackals, and hyænas. A point of considerable interest with regard to the way in which the animals contracted the disease was contributed by one hound, which always took part in the runs, but absolutely refused to join in the kills. This animal remained in perfect health, and was alive and in good health sixteen months later (July 1894).

On March 18th, 1893, eight couple of hounds, which on that date appeared in perfect health, were despatched from the Kennels to Ootakamund by sea *viâ* Calicut, in order to try the effect of the cool atmosphere of the Hills. The results were, however, disastrous, for one died during the journey, two became blind on the journey and died a few days after their arrival, three died on the 16th and two on the 21st April, and four succumbed during the next few weeks. So that, out of sixteen hounds sent to Ootakamund, twelve died, and out of the whole pack three only remained healthy.

Probably some jackals and foxes suffer from Surra, for in 1893, several of the former appeared incapable of running far, and when put up by the hounds, were caught within ten minutes, their bodies being afterwards devoured. A certain amount of carrion was picked up by the hounds during their runs; and one animal left the pack and returned to the Kennels during the following night, gorged with carrion. This animal was the first to present Surra symptoms, and died after an illness lasting 31 days.

In February 1894, Surra broke out in the Mhow pack; and several hounds were shot, after microscopical examination of their blood had been made for diagnostic purposes. The remainder of the pack were then sent down to Bombay, on the 15th February, and shipped the same evening to Calicut, *en route* for Ootakamund. Two of them, however, succumbed to the disease on the way from Bombay; the rest survived.

In 1894, Veterinary Captain G. H. Evans stated that a large number of Pariah dogs were destroyed in the city of Mandalay on account of Surra.

Veterinary Captain H. T. Pease, during his 1895-96 tour in the Punjáb, found that many of the villages in the Karnal District had lost a great number of their dogs from Surra, in addition to equines. In some villages, in fact, there was scarcely one remaining. The Canines appear to have contracted the malady through eating diseased carcasses.

SECTION II.

A.—INVESTIGATION INTO THE CAUSE OF THE OUTBREAKS IN HOUNDS.

During the early part of 1891 several English Fox-hounds from the Bombay Pack were kept under observation at the Poona Laboratory Hospital, with a view to discover whether the disease was Surra.

The symptoms noted were paroxysmal fever, temperature running up to 106·5° F., accompanied by the usual symptoms of fever; in some few cases opacity of the cornea, and more rarely extravasation of blood into the anterior chamber of the eye supervened late in the course of the disease. The blood was microscopically examined daily, but the Surra organism was never discovered. These animals suffered, shortly before death, from a gangrenous condition of the integuments of the feet; and the emaciated condition of their bodies is difficult to describe.

Early in 1893, and during the before-mentioned epidemic among the Bombay Fox-hounds and Fox-terriers, I was requested to visit the Kennels at Bandora, in order to investigate the disease on the spot. The symptoms noted in their sequence were, paroxysmal fever, anorexia; at a later date, swelling of the integument about the head and throat; injection of the conjunctival membranes; increased lachrymation, in some cases, effusion into the joints, and marked œdema of the limbs and under-surface of the abdomen; extravasations of blood into one or both anterior chambers, followed by opacity of the cornea, and later, total blindness. Some hours previous to death, marked dyspnœa would be a prominent symptom, with consequent drawing in of the chest-walls, and, in some instances, convulsive attacks intervened. During the course of the disease a progressive emaciation took place, the body at the time of death being reduced to a skeleton, and frequently presenting the appearance of a mere bag of bones.

On microscopical examination of the blood of these animals a hæmatozoon, resembling that found in the circulation of the horse, the subject of Surra, was discovered during the paroxysms. The hæmatozoon was also observed in the fluid of the anterior chamber of the eye, although, as a rule, the organisms were absent during the same period from the general circulation. In one or two later observations on inoculated animals, it was noted that the opacity of the cornea occurred during the absence of the hæmatozoon from the general circulation (intermissions), and that during the subsequent paroxysms the cornea became more or less clear.

The organisms obtained from the fluid of the anterior chamber of the eye, frequently presented hæmatozoa of two or three different sizes, but each one, as far as one could make out, fully developed, the largest-sized being at least three or four times the dimensions of those ordinarily observed in the horse. The undulating membrane was always remarkably well developed and very distinct.

With regard to the pathological lesions found at the autopsies, these varied in different animals according to the length of time the animal lived after contracting the disease, but the following account will give a very fair idea of the conditions met with.

Bodies extremely emaciated, frequent staining of the tissues, due to bile pigments. Swellings in the subcutaneous tissues of the head, throat, chest, under-surface of the abdomen or limbs. On removal of the skin, collections of jelly-like material may be found at one or several of the above-mentioned situations.

Thorax.—Sometimes a small quantity of fluid in the pleural cavities, either clear, semi-opaque or blood-stained. Occasionally pleuritic adhesions, principally near the anterior portions of the lungs.

Lungs.—Frequently the seat of a localized emphysema, at the apices or along the free borders of the organs or both. Sub-pleural extravasations of blood varying in size, and sometimes localized consolidation. *On section,* tissues frequently œdematous. Fluid in the pericardial sac, clear, semi-opaque or blood-stained, according to the condition of the visceral pericardium. *Externally,* small extravasations or petechiæ lying under the epicardium, singly or in groups, principally around the base or following the course of the coronary vessels. *On section,* the cavities contain dark-red semi-solid clots, or, in cases where the animal had lingered some hours previous to death taking place, decolourized clot, generally of a pale orange hue. Very seldom were any sub-endocardial extravasations noticed. When jaundice had been a symptom during life, the valves were found to be of a deep orange colour.

Abdominal cavity.—Usually a small quantity of a clear coloured fluid in the peritoneal cavity.

Liver.—Enlarged and undergoing more or less fatty degeneration. *On section,* organ found to contain much blood.

Spleen.—Much enlarged, numerous sub-capsular petechiæ. *On section,* tissues firm, in others soft and friable.

Kidneys.—Capsules strip easily, revealing enormous numbers of minute dark-red coloured spots. *On section,* the same spots were found to be visible all through the cortical substance, and were due to the distended condition of the Malphigian bodies. The pelvis of the kidneys frequently contains some semi-gelatinous material, stained a pale orange colour.

Stomach on section.—Frequently devoid of food: mucous membrane pale and petechiated near the pyloric opening.

Intestines.—Present a healthy appearance, as a rule.

Bladder.—In some cases, the mucous membrane at the fundus presents small extravasations of blood, lying beneath the mucous coat.

B.—Precis of spontaneous cases.

Dog (*Mike*).—Fox-terrier, aged three years. This animal was accustomed to run with the hounds and, on 8th January 1893, was amongst the dogs bitten by a hyæna. It was not until the middle of March that any symptoms of illness were noticed, but a few days later, opacity of both cornea was noted, and on the 26th, in addition to marked fever, distressing dyspnœa, the animal was nearly blind, and on 9th April succumbed. On the 8th and 9th of April, there were no hæmatozoa in the blood, but on microscopical examination of the fluid from the anterior chambers of the eye, numerous large well-developed hæmatozoa were discovered, in addition to specimens of a smaller species.

Autopsy, made directly after death ; the following conditions were noted :—

Body fairly well nourished.

Lungs.—Sub-pleural extravasations, some emphysematous patches.

Liver.—Large. *Spleen.*—Much enlarged, numerous sub-capsular petechiæ.

Kidneys.—Petechiated, &c.

Dog No. VI.—(Fox-terrier). Surra contracted spontaneously. This animal was observed to be ailing for some days, previous to being sent to the Bombay Veterinary College, on the 13th July 1893. On the 16th, the Surra hæmatozoon was observed in the blood on microscopical examination. On the evening of the 16th, the animal was sent to Poona, and admitted to the Laboratory Hospital on the morning of the 17th. From the 17th to the 25th July, on which latter date death took place, the Surra *Trypanosoma* was present on each date with the exception of the 21st. Death, 11-20 A.M., 25th.

Autopsy,—immediately after death. Body well nourished. Œdema of the under-surface of the abdomen and to a slighter degree of the extremities. Body-weight 3,738 grammes.

Thorax.—No fluid or adhesions of the pleuræ.

Lungs.—Well distended with air, surfaces petechiated.

Heart.—Weighs 46 grammes. No sub-endocardial petechiæ.

Abdominal Cavity.—Free from fluid.

Liver.—Enlarged, fairly healthy appearance.

Spleen.—Weighs 65 grammes, much increased in size, surface petechiated. *On section*, tissues somewhat soft.

Kidneys.—Right weighs 16 grammes, Left 18 grammes. Surfaces of both organs petechiated.

Stomach, Intestines, Bladder.—Healthy.

C.—Precis of experimental animals inoculated with blood obtained from spontaneous cases in the Dog.

Horse No. XCIII.—An Australian Gelding, aged and lame, otherwise healthy. Inoculated subcutaneously with 1·0 c.c. of blood, containing very numerous hæmatozoa, taken from Dog No. VI, one and a half hours after death. Swelling occurred at the seat of inoculation. Period of incubation occupied ten days. On the day following the injection of blood, a small swelling had appeared, which within the next few days increased considerably in size and become tender and tense to the touch. The swelling began to decrease in size on the 5th day, but the tenderness continued for some time longer. The hæmatozoon was not observed in the blood until four days after the diminution in size of the swelling (unusual). On the morning of the second day of the disease an urticarial eruption appeared involving the skin on the inside of the left thigh.

This eruption persisted for eight days, and then three more before it finally disappeared. On the fourth day of the latent period the temperature (37°C.) commenced to rise, and continued steadily in its course for 53 hours, when it reached a maximum of 41·2°C. (106·16°F.) ; it then fell, and next morning was 37·3°C. (99·14°F.), so that a fall of about 4°C. or 7°F. occurred in nineteeen hours. During the next two days the temperature remained low, so that the organisms appeared in the blood with a temperature of 37·2°C. The thermometric readings during the course of this case are very interesting, not only is the relapsing type of fever well marked, specially at the termination of paroxysms III, IV and V, when a maximum fall of 5·5°C. or nearly 10°F. took place, but in paroxysm I the temperature persisted high for twenty-nine hours, clearly showing that *Trypanosoma "per se"* was not the cause of the persistent high temperature, but that the accumulation of their metabolic (chemical) products in the blood must be the cause (*vide* Chart, Appendix page 213). The animal lived thirty-four days after the appearance of the disease, which was made up of six paroxysms lasting twenty days and five intermissions lasting fourteen days.

Autopsy.—Body somewhat emaciated, subcutaneous tissues bright yellow colour.

Thorax.—Pleural cavities each contain about two pints of a reddish coloured fluid, feebly alkaline in reaction.

Lungs.—Surfaces petechiated.

Heart.—8 lbs. 14½ ozs., considerably hypertrophied, orange-coloured gelatinous material surrounding base of the organ. *On section* several small subendocardial extravasations.

Abdominal Cavity.—Contains two pints of a pale coloured fluid.

Liver.—13 lbs. 15½ ozs., anterior-surface of right lobe presents numerous small concretions. *On section* tissues firm. *Spleen.*—4 lbs. 1½ ozs., much enlarged. Both surfaces dotted over with numerous small purple and bright red coloured petechiæ. *On section* tissues dark in colour, soft and flabby. *Kidneys.*—Right 1 lb. 14 ozs., Left 1 lb. 13 ozs., capsules strip easily. Few petechiæ dotted over the external surfaces of the organs. *On section* tissues pale. *Stomach, on section,* contains semi-digested food. *Cuticular* portion presents four spiroptera tumours, *villous* portion, healthy. *Intestines* healthy. *Bladder* ditto, contains no urine.

In this case the temperature, pulse, respiration, water drunk, urine passed and total urea excreted were noted.

Two Guinea Pigs were inoculated on July 25th, 1893, each with 0 25 c.c. of blood, containing very numerous hæmatozoa, taken from the heart of Dog No. VI, one hour *post mortem*

No. I Guinea Pig.—The latent period occupied 8½ days. On the evening before the appearance of the hæmatozoon in the blood, temperature rose to 40°C. and on the second evening of the disease registered 40·4°C., but never again attained the same altitude. The animal lived 18 days after the appearance of the hæmatozoon in the circulation. There were two paroxysms lasting 4 and 10 days respectively, and one intermission lasting 4 days.

No. II Guinea Pig.—The latent period occupied 10½ days. The temperature only exceeded 40° C. on one occasion during the whole period the case lasted. The animal lived 13½ days after the appearance of the hæmatozoon in the blood which consisted of one long paroxysm. Death on the 23rd August 1893 at 10·15 A.M.

Précis of experimental cases inoculated with the blood of different animals, which had been previously inoculated from the Dog.

Two Guinea Pigs were inoculated on the 7th September, each with 0·25 c.c. of blood, taken from the heart of Horse No. XCIII, 8 hours *post mortem.* Previous to death the hæmatozoa were swarming. The temperatures of both animals never exceeded that of health, and as the parasite had not made its appearance in the blood by the 9th October 1893, taking temperatures was discontinued, but the blood was examined miscroscopically for a further period of 63 days, making 101 in all.

Cat II was inoculated on the 7th September 1893, with 0·5 c.c. of blood taken from the heart of Horse No. XCIII, 8 hours *post mortem.* Previous to death the hæmatozoa were swarming. The temperature of the animal never exceeded the normal limits of health until the 6th to 8th of October, but again quickly fell. The investigation was carried on for a further period of 59 days, but as up to that time no hæmatozoa had appeared in the blood the experiment was discontinued :—

TABLE XLVI.

Showing details of animals inoculated with blood obtained from the Dog (spontaneous Surra) and passed through other animals from the dog.

Appendix No.	No.	Kind of animal inoculated.	Fluid used for purpose of inoculation.	Quantity used for purpose of inoculation.	Fluid used taken from what animal.	Date of Inoculation.	How administered.	Inoculation with fluid taken *ante mortem.*	Number of Hæmatozoa present in fluid *ante mortem.*	Inoculation with fluid taken *post mortem.*	Number of hour fluid taken *post mortem.*	Number of Hæmatozoa present in fluid taken *post mortem.*	Result of Inoculation Positive or Negative.	Date of 1st appearance of Hæmatozoa in the Blood.	Number of days after Inoculation 1st appearance of Hæmatozoa in the Blood.	Result of Inoculation.	Date of Death.	Days between inoculation and Death.	Remarks.
		Naturally contracted.																	
I	...	Dog	...	...	.....	...	.....	...	...	...	...	...	...	...	...	Death	25 7 93	...	
II {	XCIII	Horse ...	Blood.	1·25 c.c.	Dog ...	25-7-93	Subcut. ino.	,,	...	P.M.	1·5	VN	P	4 8 93	10	,,	7 9 93	44	
	I	Guinea Pig ...	,, ...	0·25 c.c.	,, ...	25-7-93	,, ...	...	...	P.M.	1·5	VN	P	3 8 93	9	,,	21 8 93	27	
	II	,, ,, ...	,, ...	0·25 c.c.	,, ...	25-7-93	,, ...	...	...	P.M.	1·5	VN	P	5 8 93	11	,,	22 8 93	28	
III {	II	Cat	,, ..	0·5 c.c.	Horse xciii.	7-9-93	,, ...	...	...	P.M.	8	A	N	...	...	...	...	...	
	I	Guinea Pig ...	,, ...	0·25 c.c.	,, ,, ...	7-9-93	,, ...	...	—	P.M.	...	A	N	...	...	...	...	...	
	II	,, ,, ...	,, ..	0·25 c.c.	,, ,, ...	7-9-93	,, ...	...	...	P.M.	...	A	N	...	...	...	...	...	

SECTION III.

Inoculated Cases of Surra.

A.—Historical References.

On October 5th, 1880, at Dera Ismael Khan, Dr. Evans* inoculated subcutaneously a Pariah dog and a bitch with four drachms of blood each; the blood containing the hæmatozoon was freshly drawn from the jugular vein of a horse suffering from Surra. Dr. Evans states "they were also allowed to drink the blood and eat the flesh of a horse which died of the disease. The dogs are thin, but they appear in good health, and I could find no parasite in their blood or anything abnormal. The bitch had a sucking pup about a month or six weeks old, in good health and free from blood parasites also; he has not been inoculated, and I have directed the meter in charge not to give him any blood or flesh. The meter himself eats the flesh of horses which die of *Surra* after it is cooked and salted and peppered."

On October 16th, 1880, Dr. Evans examined the blood of these three animals, and found a very large increase of white corpuscles in the blood of the dog, but no parasites. A few hæmatozoa and a large increase of white corpuscles in the bitch; the blood of the pup, however, was swarming with *Surra* parasites, and the animal was thinner, but showed no signs of illness.

Dr. Evans recognised that the experiment "could not be relied upon to prove that the parasite may be transmitted through the mammary gland with milk," for he had strong reasons for doubting the meter "who declared the pup had had no blood or flesh."

On October 22nd, 1880, Dr. Evans arrived with the pup in Simla, and further details were published with regard to hæmatozoon of this animal by Dr. T. R. Lewis, in a paper entitled 'Forms of the flagellated organisms in dog's blood.' The pup's blood was further examined on the following dates:—

October 26th, 1880, Simla, Hæmatozoa present in considerable numbers.

„ 29th „ }
„ 30th „ } „ „ very numerous.

November 25th, „ Calcutta, Hæmatozoa absent.
December 3rd „ „ „ readily found.
January 15th, 1881 „ „ absent.
February 12th „ „ „ Do.
„ 28th „ „ „ Do.
March 24th „ „ „ Do.

The condition and fate of this animal is not recorded.

† *Steele, J. H.*, fed a dog on January 13th, 1885, with the flesh of a mule which died of Remittent fever, and also inoculated the same animal with blood containing the parasites.

The hæmatozoon appeared in the blood on 24th January 1885, on the 28th (16th day) animal was dull, had a slight cough and exhibited pain when pressed on the loins. She was very feverish, while the blood contained parasites, and the conjunctivæ became pale in the extreme. She was allowed to eat portions of all mules which died, but her appetite became very capricious on the 25th February, "the puppy very dull, feverish and thin, with a swelling on each side of the head, much altering her appearance, also the left inguinal gland swollen and the body in general so tender that the animal shrieked when lifted from the ground."

The swelling of head increased, and on March 1st, there appeared œdema of the perinœum, and the throat and muzzle were of great size.

2nd March, seemed a little better, but it was only a temporary change.

On the 4th, she lay broadside struggling in delirium just as mules generally do, became very cold and hind quarters much swollen. Death 7 P.M. March 4th, 1885.

Autopsy after 96 hours, stomach not ulcerated.

‡ Gunn inoculated a dog on the 20th September 1887, with material from an animal destroyed on that date. On September 24th, many parasites were found in its blood, and at a later date the author observes "that the animal is now quite playful and healthy looking, nose cold, but yet the blood is crowded more or less with the special organisms, more or less numerous as indicated by the internal temperature."

B.—Précis of Cases of Inoculated Surra.

Dog I.—A young Pariah, age six months, was subcutaneously inoculated in the right inguinal region on 28th August 1892, with 0·6 c.c. of blood containing very numerous hæmatozoa, taken from the jugular vein of Donkey No. II. The original virus was obtained from the Rat (*Mus decumanus*), and passed through Horse No. LXVI, and Donkey No. II. On the day following the injection, there was a small swelling at the seat of inoculation, which further increased until the 3rd September, on which date the œdema spread from the right groin to the left side of the symphysis pubis. The latent period occupied five days. 13th, animal's left cheek and lower eyelid swollen, swelling circumscribed, and doughy on manipulation. 25th, increased lachrymation; 26th, animal weaker, unable to rise, R. 61,

* Evans, G., M. D., Report on Surra, December 1880, Appendix I.
† Steele, J. H., A. V. D.—Investigation into an obscene and fatal disease among Transport Mules in British Burmah, 1885.
‡ Gunn, Veterinary Surgeon, A. V. D.—"Quarterly Journal of Veterinary Science in India." Vol. V., 1887, page 240.

also opacity of right cornea. Urine passed involuntarily, acid, albumen 1/16th, 6 P.M., convulsed, fore limbs extended and rigid. Death 9 P.M.

The maximum temperature 40·5°C. was registered during the third intermission, and the minimum 38·2°C. during the first paroxysm. The case lasted twenty-five days after the first appearance of the *Trypanosoma* in circulation; this period was made up of three paroxysms lasting 10, 4 and 8 days and two intermissions lasting 1 and 2 days respectively.

Autopsy at 9 A.M., 27th September 1892.

Body well nourished, right cornea opaque, left slightly milky; on removing skin two glands near symphysis pubis, one on each side half inch in length. *On section* glands pale.

Thorax.—Yellow-coloured gelatinous material under surface of sternum. *Lungs* localized emphysema, sub-pleural extravasations of blood. *On section* and pressure, frothy mucus exudes from tissues. *Pericardial Sac.*—Contains 28 c.c. straw-coloured fluid, few flakes of attached surface of left ventricle. *Heart* externally no petechiæ. *On section* endocardium pale, no petechiæ. *Stomach* healthy. *Liver* large, tissues fatty. *Gall bladder* distended, green fluid. *Spleen*, 90 grammes, considerably enlarged. Capsule petechiated. *On section* tissues soft. *Kidneys.*—Right weighs 15 ozs.=42·45 grammes. Left 1 75 ozs.=49·52 grammes. Capsules strip easily, surfaces pale, petechiated and lobulated. *On section* cortical portion pale and narrow. *Intestines* healthy appearance. *Bladder* ditto. *Brain* membranes pale, tissues appear healthy, no fluid in the ventricles.

Dog No. II.—A Pariah, aged three years, was subcutaneously inoculated on 1st January 1893, with 1·5 c.c. of blood containing very numerous hæmatozoa taken from the heart of a rat (*Mus decumanus*) immediately after death. The blood of this animal was examined until death took place on the 18th February 1893, a period of 49 days, but during this interval no hæmatozoa were observed. For the first six weeks, the temperature registered within normal limits or sub-normal, but during the last week of life the maximum recorded was 39·8°C. It is probable that if a Guinea Pig had been inoculated with the blood of this dog just before or after death, the animal might have contracted the disease.

Dog No. III.—A Pariah, was inoculated subcutaneously on the 16th January 1893, with 1·0 c.c. of blood containing swarms of hæmatozoa derived from the heart of a rat (*Mus decumanus*) immediately after death. The temperature on one occasion, 3rd March 1893, registered 40·6°C., but the same evening fell to 38·6°C. The blood of the animal was microscopically examined daily, with negative results, from January 15th to April 12th, 1393, a period of eighty-eight days. After the latter date the experiment was discontinued.

Dog No. IV.—A Pariah, some 6 or 8 months old, was subcutaneously inoculated on the 22nd January 1893, with blood containing swarms of hæmatozoa derived from the rat (*Mus decumanus*) immediately after death. The temperature on the evening previous to inoculation registered 39·8°C., but the blood was healthy. On the evening of the 24th, temperature 40°C. Death occurred at noon on the 28th January. Temperature 36·2°C.

Autopsy.—Organs presented a healthy appearance.

Dog No. V.—A Pariah, ten months old, was subcutaneously inoculated on the 23rd January 1893 with 1·0 c.c. rat's blood containing swarms of hæmatozoa, taken from the heart immediately after death of the animal. The temperature remained low until the 10th February; for five days it rose, and registered between 40·2° and 40·6°C.; it then fell, but again rose before death which occurred on the 20th February 1893. No hæmatozoa were discovered in the blood, although daily microscopical examinations of it were made.

Autopsy.—Enlarged spleen, no marked pathological changes.

Dog No. VI A.—A Pariah puppy, aged four months, was inoculated subcutaneously on 14th December 1895, with 0·4 c.c. of blood taken from the jugular vein of Horse No. 1952. The latent period occupied three and a half days. The maximum temperature registered was 40°C. on the night of the 19th December, the minimum 38°C. on the evening of the 25th. The hæmatozoon was present in the blood from the morning of the 18th, until death, which occurred during the night of the 29th and 30th December.

Autopsy.—On December 30th, 1895, at 11-30 A.M. Spleen and liver enlarged.

Dog No. VII.—A Pariah puppy, four months old, was inoculated subcutaneously on the 14th December 1895, with 1·25 c.c. of blood drawn from the jugular vein of a black Colt No. 1991, suspected to be the subject of Surra. As at a later date, January 23rd, 1896, no hæmatozoa had appeared in the circulation, and as the animal was in perfect health, it was re-inoculated at 5 P.M. on the above date, by making a scratch on the thigh, and placing therein a trace of blood containing a few hæmatozoa derived from Donkey No. VI. The latent period occupied 10·5 days. The maximum temperature 40·6°C. was registered during the second paroxysm and third intermission, and the minimum 37·4°C. during paroxysm four. The animal lived thirty-eight days after the appearance of the organism in its circulation. There were five paroxysms lasting 3, 5, 21, 1 and 5 days, and four intermissions lasting 1, 2, 2, 1 days, respectively. Death took place on the 11th March 1896.

Autopsy.—9-30 A.M. Body fairly well nourished. *Rigor mortis* strongly marked. *Thorax* free from fluid, no pleural adhesions. *Lungs* deeply congested in variegated patches, no consolidation. *Pericardial sac* contains 170 c.c. of a blood-stained fluid. *Heart*, weight 66 grammes. External surface of organ very pale. *On section* no sub-endocardial extravasations. *Abdominal cavity* free from fluid. *Liver*, weight 389 grammes, enlarged. Tissues fatty. *Spleen* enlarged, 38 grammes. Tissues

firm. *Kidneys.*—Right weighs 21·5 and Left 22 grammes. Tissues present healthy appearance. *Stomach* ditto, *Bladder* ditto.

Dog No. VIII.—Aged four months, was given some blood clot to eat at 6 P.M. taken from the heart of Bullock No. 13, which died of Surra on 16th December 1895. As up to the 30th December, the temperature of the animal remained within normal limits, and the blood daily examined microscopically showed no signs of the *Trypanosoma*, re-inoculation was performed on the above date. One cubic centimetre of blood containing a few hæmatozoa taken from the heart of Dog No. VI, directly after death, was subcutaneously injected into the right inguinal region. The latent period occupied eleven days. The maximum temperature recorded was 39·5°C. during the first paroxysm, during which period the animal succumbed on January 4th, 1896, at 4 P.M.

Autopsy.—Immediately after death. Body well nourished. *Thorax* contains no fluid, no pleural adhesions. *Lungs* collapsed, petechiated. *Pericardial Sac* contains 23 c.c. of a semi-opaque fluid. *Heart.*—External surface presents healthy appearance. *On section* no extravasations. *Liver* enlarged. Tissues appear healthy. *Spleen* enlarged, convex surface petechiated, tissues firm. *Kidneys.*—Capsules strip easily, surfaces petechiated. *Stomach*—Mucous membrane presents healthy appearance. *Bladder* ditto.

Dog No. IX.—Pariah puppy, four months old, subcutaneously inoculated on the 29th December 1895, with 1·25 c.c. of blood containing hæmatozoa, taken from the jugular vein of Bullock No. 152 *ante mortem*, at Karnal, Punjab. The latent period occupied a period of five days. The maximum temperature, 40·8°C. during the period of disease, was recorded during Paroxysm VI, and the minimum 35·2°C. during Paroxysm IX, shortly before death. During the case, the muzzle became swollen between the 24th February and 3rd March; on the latter date there was increased lachrymation. Opacity of the left cornea was first noted on the 15th March, and gradually increased, until on 27th of that month the animal was blind of that eye. After the first appearance of the organism in the blood the animal survived ninety-four days, made up of nine paroxysms lasting 46 days, and eight intermissions lasting forty-eight days. Death took place on the 5th April 1896, at 8·50 A.M.

Autopsy—40 minutes after death. Body somewhat emaciated. Gelatinous swellings lying subcutaneously on either side of the forehead and on each side of the jaws. Parotid and sub-maxillary glands increased in size and hard to the touch. *Thorax.*—No fluid in the pleural cavities, no pleural adhesions. *Lungs* pale pink colour, distended with air. *Right* presents 7 or 8 sub-pleural extravasations, circular in form and half inch in diameter, somewhat raised, dark brick red in colour. *Left*, free from petechiæ. *Pericardial Sac* few c.c. of clear fluid. *Heart*—External surface free from pathological changes. Internal surface, no sub-endocardial petechiæ, blood fluid. *Abdominal cavity* contains 35 c.c. of a semi-opalescent fluid. *Liver* large, presents healthy appearance. *Gall bladder* distended with dark green bile. *Spleen* large, granular on surface, no petechiæ. *On section* tissues firm. *Kidneys* appear healthy. *Stomach* no food, small quantity of a yellowish fluid, mucous membrane pale in colour, two small ulcers invading mucous coat close to pyloric end of the organ. *Mesenteric glands* are somewhat enlarged, dark in colour, and matted together, the tissues lying superior to the kidneys are œdematous, and contain a fair amount of gelatinous material. *Intestines* healthy. *Bladder* ditto.

Dog No. X.—A Pariah, about 12 months old, was subcutaneously inoculated in the inguinal region with 0·5 c. c. of blood taken 1 hour *post mortem* from the heart of Dog No. VII. The latent period occupied six days. The highest temperature, 40·8°C., was recorded during the one paroxysm which lasted for 21 days, when death occurred. For the last five days of life the organisms were swarming in the blood.

Dog No. XI.—A Pariah, aged two years, body-weight 16·140 kilograms, was inoculated subcutaneously at 5 A.M. on 28th October 1897 with 0·5 c.c. of blood drawn from the jugular vein of a Surra horse, but during an intermission; the *Trypanosoma* was therefore absent. The latent period occupied six days. The maximum temperature, 41·0°C., was registered during the first paroxysm, the minimum 38°C. during the second intermission. The case lasted 28 days after the first appearance of the *Trypanosoma* in the circulation. This period was made up of three paroxysms lasting 9, 3 and 14 days, and two intermissions lasting one and one day respectively. Death took place on the 1st December 1897.

Autopsy at 11-30 A.M. Body-weight 14:31 kilograms, total loss 1·830 kilograms. Body slightly emaciated, no subcutaneous swellings. *Thorax*—No pericardial fluid, no adhesions. *Lungs* collapsed, small patches of emphysema dotted over Right lung. *Left* free. *On section* tissues somewhat dark, on pressure frothy mucus exudes. *Trachea* contains frothy mucus. Trachea and lungs weigh 375 grammes. *Pericardial Sac* contains few cubic centimetres of fluid. *Heart* weighs 148 grammes. Both sides of heart dilated, but externally no changes. *On section* cavities filled with dark firm clots, small quantity of fluid blood drips from the clots. No sub-endocardial petechiæ. *Abdominal cavity* contains no fluid. *Liver* large, weighs 808 grammes. *On section* tissues firm. *Gall bladder* distended with dark green bile. *Spleen* much enlarged, weighs 305 grammes, tissues soft and semi-fluid. *Stomach.*—Mucous membrane, although pale, present a healthy appearance; few petechiæ at pyloric extremity. *Kidneys.*—Right weighs 46, Left 48 grammes, capsules strip easily. *On section* cortical portion healthy, pyramids petechiated. *Intestines* healthy. *Bladder* ditto.

Dog No. XII.—A Pariah, aged two and half years, body-weight 10·7, was subcutaneously inoculated on 31st October 1897 with 0·6 c.c. of blood containing very numerous organisms, drawn from the jugular vein of a Surra Horse at Kathgodam. The latent period occupied four and half days. The

maximum temperature, 40·8°C., was registered during the second paroxysm, and the minimum 35·5°C. during the same period. The case lasted twenty-four days after the first appearance of the *Trypanosoma* in the blood. This period was made up of two paroxysms lasting 12 and 11 days respectively, and one intermission lasting one day. Death took place in the night of the 27th and 28th of November.

Autopsy at 10-30 A.M., 28th November 1897. Body-weight 8·7 kilos, total loss equals to 2 kilograms. Body much emaciated. Some subcutaneous gelatinous deposits around the superior maxillary region, giving a peculiar expression to the face of the animal. *On section* tissues of the body stained a yellowish orange colour. *Thorax.*—No fluid, no adhesions of pleuræ. *Lungs* collapsed, localized emphysema along the free edges of both organs. *On section* blood exudes from the cut surfaces and on pressure, small quantity of frothy mucus exudes. Lungs and trachea weigh 205 grammes. Pericardium contains a small quantity of a transparent, somewhat reddish coloured, fluid. *Heart* weighs 60 grammes. *Externally* the organ presents a petechiated condition of the right and left auricles, ventricles free. *On section* aorta and great vessels stained a bright gamboge colour. *Right Auricle* sub-endocardial petechiæ. *Right Ventricle* pale, contains few firm jelly-like clots, brownish in colour, resembling material frequently found round the base of the heart in Surra Horses *post mortem*. *Left Auricle* few sub-endocardial petechiæ. *Left Ventricle*, pale and containing clots as in right ventricle. *Abdominal Cavity*, no fluid. *Liver* weighs 555 grammes, large, streaked, dark red and yellow, looks fatty. *On section* contains much fluid blood; microscopical examination, fatty change. *Stomach.*—Mucous membrane pale but healthy. *Spleen* weighs 116 grammes, much enlarged, concave surface petechiated; *on section* tissues dark in colour, but fairly firm in consisteney. *Kidneys*. Right weighs 47, Left 45 grammes. Capsules strip easily. Cortex pale. *On section* tissues pale. *Bladder* healthy. *Intestines* ditto.

INOCULATED

TABLE

Showing the number of Paroxysms and Intermissions which occurred in the course of each Case, together with their

Number.	Animal.	Fluid used.	Quantity used.	Fluid taken from what Animal.	Ante Mortem or Post Mortem.	Date of Inoculation.	How administered.	Latent Period.		Hæmatozoa.		Paroxysm. I		
								Length in Days.	Maximum and Minimum Temperature °C.	Date of first Appearance.	Temperature °C. at the time of first Appearance.	Length in Days.	Maximum and Minimum Temperature °C.	Maximum number of Hæmatozoa.
I	Dog	Blood...	0·6 c. c. (V. N.)...	Donkey II ...	Ante mortem.	28th August 1892 ...	Sub-cutaneously.	5	39·8 38·8	2nd September 1892.	38·9	10	41·0 38·2	V.N.
II	Do.	,, ...	1·5 c. c. (V. N.)...	Rat (M. D) ...	Immediately after death.	1st January 1893 ...	,, ..	Death.		18th February 1893.	...	Result		Nil.
III	Do.	,, ...	1·0 c. c. S.) ...	Rat (M. D.) ...	Do. ...	16th January 1893.	,, ...	,,		12th April 1893 ...	...	Do.	Do.	
IV	Do.	,, ...	1·0 c. c. (S.) ...	Rat (M. D.) ...	Do. ...	22nd January 1893.	,, ...	,,		28th January 1893..	...	Do.	Do.	
V	Do.	,, ...	1·0 c. c. (S.) ..	Rat (M. D.) ...	Do. ...	23rd January 1893..	,, ...	,,		20th February 1893.	...	Do.	Do.	
VIA.	Do.	,, ...	0·4 c. c.	Horse No. 1952 ...	A.M.	14th December 1895.	,, ...	3·5	...	18th December 1895.	...	12	40·0 38·1	S.
VII	Do. ...	,, ...	1·25 c. c.	Horse No. 1991 ...	A. M.	Do. ...	......	...	...	.....	...	...	...	...
	Re-inoculated	,, ...	Trace	Donkey VI ...	A. M.	23rd January 1896...	Into scratch ..	10·5	39·0 37·8	3rd February 1896...	38·0	3	40·0 38·0	N.
VIII	Dog ...	,, ...	.....	Bullock No. 13 C. H.	P.M.	16th December 1895.	Fed on blood clots from heart.	...	...	.....	...	...	...	...
	Re-inoculated	,, ..	0·6 c. c.	Dog No. VI. A ...	P. M.	30th December 1895.	.....	11	38·8 37·4	10th January 1896...	38·2	4	39·5 36·4	S.
IX	Dog	,, ...	1·25 c. c.	Bullock No. 152 .	A.M.	29th December 1895.	Sub-cutaneously.	5	39·1 38·6	3rd January 1896 ..	36·8	8	40·4 36·3	N.
												V I.		
												5	40·8 38·8	V.N.
X	Do.	,, ...	0·5 c. c.	Dog VII	P.M.	11th Mareh 1896 ...	,, ...	6	38·6 37·2	17th March 1896 ...	39·6	21	40·8 37·0	S.
XI	Do.	,, ...	0·5 c. c.	Horse (Tonga) ...	A.M.	28th October 1897...	,, ...	6	39·4 38·5	3rd November 1897.	39·1	9	41·0 38·4	V.N.
XII	Do.	,, ...	0·6 c. c. (V. N.)	Horse Tonga) ...	A. M.	31st October 1897...	,, ...	4	...	4th November 1897.	...	12	40·2 38·6	S.

CASES.

XLVII.

Duration, Maximum and Minimum Temperatures, and the Maximum number of Hæmatozoa present during the former.

Intermission. I		Paroxysm. II			Intermission. II		Paroxysm. III			Intermission. III.		Paroxysm. IV.			Intermission. IV		Paroxysm. V			Intermission. V.	
Length in Days.	Maximum and Minimum Temperature °C.	Length in Days.	Maximum and Minimum Temperature °C.	Maximum number of Hæmatozoa.	Length in Days.	Maximum and Minimum Temperature °C.	Length in Days.	Maximum and Minimum Temperature °C.	Maximum number of Hæmatozoa.	Length in Days.	Maximum and Minimum Temperature °C.	Length in Days.	Maximum and Minimum Temperature °C.	Maximum number of Hæmatozoa.	Length in Days.	Maximum and Minimum Temperature °C.	Length in Days.	Maximum and Minimum Temperature °C.	Maximum number of Hæmatozoa.	Length in Days.	Maximum and Minimum Temperature °C.
1	39·6 39·3	4	40·2 39·5	V. N.	2	40·5 40·1	8	40·4 38·9	Teemin	g.	Death during Paroxysm III.				...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Death.		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1	37·6 38·4	4	40·6 37·8	V. N.	2	39·2 38·6	21	41·0 38·6	N.	2	40·6 38·7	4	40·0 37·4	V. N.	Death	during	Paroxysm IV.		...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Death during Paroxysm I		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
3	39·4 38·0	16	40·2 37·6	S.	4	39·4 37·0	4	40·0 37·8	V. N.	8	39·6 37·6	3	40·0 39·4	F.	8	40·6 38·2	1	39·6 39·2	F.	11	40·3 38·4
VI.		VII			VII		VIII			VIII		IX									
9	40·4 37·6	2	40·0 39·0	F.	3	40·2 38·2	6	39·6 37·4	V. N.	2	38·4 37·6	1	35·2	V. N.	Death	during	Paroxysm IX.		...	...	...
Death during Paroxysm I.		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1	39·4 38·5	3	40·2 38·6	N.	1	38·5 38·0	14	40·4 35·5	S. .	Death during Paroxysm III					...	...	...	...	...	...	...
1	39·3 38·3	11	40·8 35·5	S.	Death during Paroxysm III					...	...	...	...	...	...	...	...	...	...	...	...

PART VI.

EXPERIMENTAL INOCULATION OF ANIMALS WITH THE SOILED BLOOD OF FISH.

B 2204—39

SECTION I.

Historical References.

In the blood of different kinds of fish protozoa have been recognised since 1841. At that date, **Valentin* described animalculæ in the blood of the common frog 7 to 15$_\mu$ in length, endowed with amœboid movements.

The first observation concerning protozoa in the blood of Batrachians is due to †*Glüge* in 1842 This observer discovered in the heart of a frog a microscopic organism, of some length, terminating in a point at both extremities, and presenting on the right side three fairly long appendices (probably an undulating membrane), which it was able to move with great rapidity; at the same time the organism moved quickly from one position to another. The body was transparent, and did not present any signs of organisation.

In a more recent and complete investigation of the hæmatozoa of fish the Russian naturalist ‡Mitrophanow describes under the name of *Hæmatomonas cobitis* an organism observed by him in the blood of the *cobitis fossilis* or mud-fish. The organisms at first looked like minute nematodes, but the appearances and changes which took place on further examination showed nothing in common with worms. Mitrophanow then thought that they were possibly the Cytozoa described by Gaule, but this idea was dismissed by the fact that they were found in the blood to which no salt solution had been added. The organisms were extremely difficult to examine on account of their rapid movement, but as the movement gradually ceased, the length was found to vary from 30 to 40 $_\mu$, and the breadth from 1 to 1·5 $_\mu$. The body presented on one of its sides a large undulating membrane twisted spirally; at one extremity of the organism a long flagellum was observed, which gradually became thinner and thinner like the lash of a whip. In progression this end was always directed to the fore, the other extremity of the body was much shorter and less pointed. At the moment of death the flagellum and membrane became retracted, and the organism assumed the appearance of a simple shapeless mass of protoplasm.

Mitrophanow also described the organism found in the Carp (*Carassius vulgaris*) under the name of *Hæmatomonus carassii*. This second organism very much resembles the one previously described, but it is larger, and the undulating membrane straighter and its activity less marked. These flagellated protozoa were observed in the blood of all mud-fish examined, with one exception, and were in greater numbers in the hot months. In the Carp they were only found occasionally.

In 1888 §*Chalachnikow* found the hæmatozoon of Lewis in the blood of the *Mus decumanus* and *Cricetus frumentarius*.

At a later date 1889, ¶*Danilewsky* observed the same form of parasites in different fish (*Cyprinus carpio, C. tinca, Cobitis fossilis, C. barbatula, Esox lucius, Perca fluviatilis, etc.*) He has given them the name of *Trypanosoma piscium*, and recognises two varieties, which correspond almost exactly to those which Mitrophanow recorded.

Labbé observed in the blood of a leech, after three months' confinement, hæmatozoa corresponding to those observed in the horse.

SECTION II.

Results of observation conducted in India.

Between the end of the year 1890 and 1895, we observed in the blood of certain species of fish three varieties of Trypanosoma, differing in size, but all closely resembling the fully developed hæmatozoon of Surra; while a second form of flagellated protozoon was found in bottom or mud-fish. This latter organism was not furnished at this stage of its development with an undulating membrane. The shape of the body was round. Members of the following families and Genera taken from rivers in the Deccan, on the West Coast of India, were submitted to examination.

(*a*) *Rhynchobdellidæ*.

Genera i.—*Rhynchobdella*—sp. *R. Aculeata*.

„ ii.—*Mastacembelus*—sp. *M. Armatus*.

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* *G. Valentin.*—Ueber ein Entozoon im Blute Von Salmofario. Müller's Archives—1841, page 435.

† *G. Glüge.*—Ueber ein eigen thumliches Entozoon im Blute des Frosches. Müller's Archives—1842, page 148.

‡ *Mitrophanow P.*—Nene monadenformige Parasiten des Fischbluts. Biologisches Centrabblatt. Band III, Marz 15th, 1883, page 35.

Gaule.—Ueber würmchen welche ausdem Froschblut Korperchen Auswandern. Archiv: fur: Anat and Physiologie, 1880, S. 57.

§ *Chalachnikow.*—Rech. Sur les parasites du sang chez les animaux á sang froid et á sang chaud. Kharkov, 1888.

¶ *Danilewsky.*—La parasitologie comparee du sang, enfrancais, 1889, Kharkoff.
(ii) Trypanosomes et Trypanomonades.
(iii) Hematozoaires des Tortues.

‖ *Labbe.*—Note Suz un nouvean parasite du sang. Bulletin de la Soc Zool de France, 1891. Tome XVI, No. 8

(*b*) *Cyprinidæ.*
Genus—*Barbus.*—sp. *B. Carnaticus.*
(*c*) *Ophiocephalidæ.*
Genus—*Ophiocephalus*—sp. *O. Striatus.*

It was discovered that the organisms in the blood of certain fish are present in greatest numbers, during May and June, the hottest months of the year, but decrease or absent themselves after the rains have fairly set in. When the blood of a fish under observation was examined microscopically and no *Trypanosoma* discovered, it was frequently found in the fluid obtained by passing a scalpel gently over the surface of the gills. At a later date investigations were instituted with a view to discover whether the blood of fish obtained from waters in localities where Surra is enzootic, presented any differences (i) during the hot season, when no cases of the disease exist, (ii) during the early part of the rains, before the disease has manifested itself in animals. These observations were carried out at Kathgodam, Kumaun Division, N.W.P., Saharanpur, N.W.P. and Karnal in the South-Punjab.

The following are the results of the hot season's investigation.

A distinction with regard to the presence of hæmatozoa had been previously observed between fish inhabiting the bottom of ponds and rivers (mud-fish) and those which occupy the water above the mud. After microscopically examining the blood of a few of the latter in which few or no hæmatozoa were found, our attention was devoted to the examination of mud-fish. For the purpose of comparison examples of the following fish when possible were obtained from—

(i) the Western Jumna Canal, running water;
(ii) a pond, stagnant water;
(iii) the old river Jumna at Niawal, back water.

The results of the microscopical examination of the fish examined are as follows:—

* *Cachri* or *chachări* (Punj.).—This fish belongs to the order *Acanthopterygii*; family *Labyrinthici*; genus *Trichogaster*. It corresponds closely with the species *T. Faciatus.*

Many specimens were caught in ponds supplied with water from the river Jumna. These presented alternate blue and yellow bands descending obliquely downwards and backwards from the back to the abdomen. The dorsal and anal fins are blue in colour, fringed with a narrow line of red.

Depôt Pond.—In June 1896 the blood of fifteen specimens was examined. One† presented over 200,000 of the small round variety of hæmatozoa in each c. c. of blood examined. In three fish the hæmatozoa were swarming (over 50 in a field of the microscope), in one numerous (20), in nine few (5), and in one specimen no parasites were found.

* TABLE XLVIII.

Giving the measurements of thirteen specimens of Trichogaster for diagnostic purposes.

Serial Number.	Number of coloured bands on body.	Length over all.	Length of head.	Length of body.	Length of tail.	Vertical height of body.	Length of Pectoral fin.	Pectoral fin, number of spines.	Number of spines, Dorsal fin.		Number of spines, Anal fin.		Caudal fin, number of spines.	Length of pectoral Appendages.	Remarks.
									Anterior portion.	Posterior portion.	Anterior portion.	Posterior portion.			
		Inches.	Inches.	Inches.	Inches.	Inches.	Inches.							Inches.	
1	11	$3\frac{1}{2}$	$\frac{7}{8}$	$1\frac{3}{4}$	$\frac{3}{4}$	$1\frac{1}{16}$	$\frac{3}{4}$	10	16	10	17	13	17	$2\frac{1}{8}$	Bands varied from 8 to 13 in number, total length $1\frac{28}{32}$ to $3\frac{1}{2}$ inches, length of Pectoral fin from $\frac{12}{32}$ to $\frac{24}{32}$ of an inch, Candal fin $\frac{14}{32}$ to $\frac{28}{32}$ inch, D. $\frac{16-17}{8-11}$, P. 8—10, C. 15—18, A. $\frac{16-17}{10-16}$.
2	12	$3\frac{1}{4}$	$\frac{3}{4}$	$1\frac{3}{4}$	$\frac{3}{4}$	1	$\frac{11}{16}$	10	16	9	16	15	18	$2\frac{1}{8}$	
3	9	$3\frac{1}{16}$	$\frac{3}{4}$	$1\frac{5}{8}$	$\frac{11}{16}$	$1\frac{1}{16}$	$\frac{3}{4}$	10	16	10	17	14	17	2	
4	11	$3\frac{5}{16}$	$\frac{13}{16}$	$1\frac{13}{16}$	$\frac{11}{16}$	$1\frac{1}{8}$	$\frac{3}{4}$	10	16	11	16	15	17	2	
5	12	$3\frac{3}{8}$	$\frac{13}{16}$	$1\frac{13}{16}$	$\frac{3}{4}$	$1\frac{1}{8}$	$\frac{3}{4}$	9	16	10	16	14	16	$1\frac{5}{8}$	
6	10	$3\frac{3}{16}$	$\frac{13}{16}$	$1\frac{11}{16}$	$\frac{11}{16}$	$1\frac{1}{16}$	$\frac{3}{4}$	8	17	10	16	15	16	$2\frac{1}{8}$	
7	10	$3\frac{1}{2}$	$\frac{13}{16}$	$1\frac{13}{16}$	$\frac{7}{8}$	$1\frac{1}{8}$	$\frac{3}{4}$	9	16	11	16	15	15	$2\frac{1}{8}$	
8	11	$3\frac{7}{16}$	$\frac{13}{16}$	$1\frac{13}{16}$	$\frac{13}{16}$	$1\frac{1}{16}$	$\frac{3}{4}$	9	17	10	17	16	15	$2\frac{1}{16}$	
9	10	$3\frac{1}{8}$	$\frac{11}{16}$	$1\frac{13}{16}$	$\frac{5}{8}$	$1\frac{1}{8}$	$\frac{11}{16}$	9	17	8	17	15	15	2	
10	8	$3\frac{3}{16}$	$\frac{11}{16}$	$1\frac{11}{16}$	$\frac{13}{16}$	$1\frac{1}{16}$	$\frac{11}{16}$	9	16	9	17	14	15	$1\frac{15}{16}$	
11	8	3	$\frac{11}{16}$	$1\frac{5}{8}$	$\frac{11}{16}$	$1\frac{1}{16}$	$\frac{11}{16}$	9	17	10	17	10	15	$1\frac{13}{16}$	
12	13	2	$\frac{1}{2}$	$1\frac{1}{16}$	$\frac{7}{16}$	$1\frac{3}{16}$	$\frac{3}{8}$	8	16	8	16	15	15	$1\frac{3}{16}$	
13	13	$1\frac{7}{8}$	$\frac{1}{2}$	$\frac{15}{16}$	$\frac{7}{16}$	$\frac{3}{4}$	$\frac{3}{8}$	8	16	10	17	15	15	$1\frac{1}{4}$	

† Negative results followed the inoculation of small animals inoculated with this hæmatozoon.

Old Jumna River.—The hæmatozoa were found to be swarming in one specimen, few in a second, and absent from the blood of seven.

Grisauli or *Girai* (Punj), *Murral* (*Hindustani*).—These fish belong to the order *Acanthopterygii*; family *Ophiscephilidæ*; genus *Ophiscephalus*; species *O. Striatus.*

Depôt Pond.—A large variety of hæmatozoon was present in the blood of six specimens of this species of fish examined.

Old Jumna River.—The large variety of hæmatozoon was found in the blood of three fish examined.

Singhi or Tinghi.—This fish belongs to the order *Physostonii*; family *Siluridæ*; genus *Macrones*; species *M. Seenghala* and *M. Tengara.*

These fish were caught only in the Old Jumna River, but were not seen in the West Jumna Canal, or in the neighbouring ponds. The small variety of the hæmatozoon was found in the blood of all the specimens examined; they never exceeded five in a field of the microscope, Zeiss D, ocular No. 4.

Blood from numerous other species of fish obtained from a similar source to the above mentioned was submitted to microscopical examination, but no hæmatozoa were found in any of the specimens. The names of the fish were as follows:—

Pattia (Hindi), *Barbus stigma.*
Mohaylee (Hindi), *Labeo diplostomus.*
Purri (Punjabi), *Notopterus kapirat.*
Kugga (Punjabi), *Clarias magur.*
Rewah or Rohwa (Hindi), *Cirrhnia reba.*

Rainy Season Observations.—Exactly the same ground was gone over at the beginning of September, and similar investigations to those previously recorded during the hot season tour were made.

Depôt Pond—Cacheri (*Trichogaster faciatus*, or a variety of this species).—In the blood of eleven specimens examined, the small variety of the hæmatozoon was found present, varying from numerous to few; and absent from the circulation of seven.

Old Jumna River.—The small variety of hæmatozoon was present in one, and absent from the blood of two fish examined.

Old Jumna River.—Grisauli or *Girai* (*Ophiocephalus striatus*). No hæmatozoa were found in the blood of the three specimens examined.

Jumna River.—Singhi (*Macrones seenghala*).—The blood of three specimens of this species was submitted to examination with the result that the large variety of hæmatozoon was found to be numerous in one and absent from two fish.

Specimens of blood were likewise taken from fish of different genera, as was the case during the investigations conducted during the hot season, but the results proved again to be of a negative character.

SECTION III.

Precis of Experimental Cases.

Horse No. XLIII.—This animal was subcutaneously inoculated on September 22nd, 1891, over the right scapular region with blood containing hæmatozoa resembling those found in the blood of Surra cases, mixed with normal saline solution, taken immediately after death from a specimen of "*Rhynchobdella aculeata*; *Baum* (Hindustani) *Warm* (Mahratta). A raised tumour appeared at the seat of inoculation on the following day, which continued to increase in size until the 24th, and then gradually disappeared. A few petechiæ appeared on the conjunctival membranes on the 26th, together with a muco purulent discharge from the left nostril. Again well marked ecchymoses were noted on the 23rd October and 11th November, together with a yellow colouration of the visible mucous membranes on the latter date.

The *temperature* which registered 35·7° C. at the time of inoculation during the next three weeks oscillated between 38·7° C. and 35·5° C., but from the 12th October to the 3rd November presented well marked evening exacerbations, and morning remissions frequently varying as much as 2° C. between the two observations. On the 4th November, however, the temperature registered 35·7° C. in the morning followed by an evening temperature of 37·8° C., and from this time it became gradually elevated until a maximum of 39·8° C. was attained at midday on the 11th of November. From this time until death, which occurred on the 23rd November, marked remissions and exacerbations took place several times varying as much as 3°C. between two registered readings.

Autopsy.—Body somewhat emaciated, tissues tinged an orange colour, few dark-red ecchymoses were present on the membranæ nictitantes, and there was slight œdema of the hind limbs. *Thorax* was free from fluid and pleuritic adhesions. *Lungs.*—Both apices were the seat of a localized emphysema. The right also presents a patch of consolidation on the superior surface near the apex which on section was found to have the lobules divided off from one another by a deposition of jelly-like exudation. The tissues otherwise presented a healthy appearance. The *Pericardial* sac contained 1½ oz. of a turbid yellow

coloured fluid. *Heart.*—5 lbs. 10 ozs., external surface presented a few sub-pericardial extravasations. *On section* the cavities contained coloured blood clots, and the right ventricle a few sub-endocardial extravasations. The other cavities presented a healthy appearance. *Abdominal cavity* was free from fluid. *Liver*, normal in size. There were signs of old perihepatitis on the right lobe. *On section* tissues healthy, *Spleen* enlarged—double normal size—presented a few sub-capsular petechiæ, tissues soft. On section *kidneys* presented a healthy appearance. *Stomach.*—The villous portion was invaded by a small *spiroptera* tumour, otherwise healthy. *Intestines* and *Bladder* present a normal appearance.

Horse No. XLVII.—This animal was subcutaneously inoculated on the 15th October 1891, over the left scapular region with blood containing hæmatozoa mixed with normal saline solution. The blood was removed immediately after death from the heart of a large sized specimen of "*Barbus carnaticus.*" A circular raised swelling appeared on the following day at the seat of the injection of blood and continued to increase in size, until the evening of the 17th, after which it remained stationary until the 19th, and then gradually became less, and finally disappeared. No general symptoms of disease supervened, so the animal was re-inoculated on the 29th October, with blood from a similar source. Again swelling and œdema followed at the seat of the injection, the former measured 5″×4″ on the morning of the 31st, but by the 2nd November had again disappeared to a considerable extent. In this instance also no symptoms supervened and the blood, which was examined daily, maintained a healthy condition.

On the 19th November, the animal was again re-inoculated with blood from a specimen of "*Barbus carnaticus*" as before. No hæmatozoa were found in the blood, but on the 9th, 10th, 11th and 12th December, several Næmatode hæmatozoa were observed daily. The temperature from October 8th until the beginning of March, on only one occasion registered 40°C., and that was on the 16th November; it, however, for long periods, showed marked morning remissions and evening exacerbations.

On March 9th, 1892, this animal was finally inoculated with 1·0 c c. of Horse Surra blood, containing swarms of hæmatozoa, taken from the jugular vein of No. LV. The *latent period* occupied five days. On the third day after the injection of blood, a small raised tumour, the size of a walnut, appeared at the seat of inoculation which gradually increased, and reached considerable dimensions, *viz.*, 7″ × 4·5″ on the morning of the 13th; but by the 14th, when the hæmatozoon was discovered in the blood, the tissues were found to have lost some of the tension and tenderness previously observed. The temperature gradually became elevated on the evening of the last inoculation, and steadily rose until noon on the fourth day of the disease, when the thermometer registered 42·1°C. (107·7°F.), but by the morning of the 5th day had fallen to 37·3°C., a difference of 4·8°C. (8·6°F.). The temperature again rose on the 7th to 40·6°C., and on the 10th to 41·5°C., and death took place on the 29th March 1892, the 16th day of the disease.

Autopsy at 9·30 A.M. on the 29th March.—Body fairly well nourished. There was slight œdema of the sheath, and under-surface of the abdomen. *Cavity of the Thorax* contained no fluid, and there were no pleuritic adhesions. *Lungs* pale pink in colour, localized emphysema at the apices, otherwise healthy. *Heart* apparently healthy. *Liver* old perihepatitis, few calcareous bodies on the surface of the organ. *On section* tissues healthy. *Spleen* enlarged to 2·5 normal size, no sub-capsular petechiæ. *Kidneys present* a healthy appearance. *Stomach.*—Cuticular portion healthy. Villous portion presents a tumour 1·75″ in diameter due to "*spiroptera*" (megastoma). *Intestines* present a healthy appearance.

Horse No. XXX.—This animal was subcutaneously inoculated on the 11th August 1891, with blood containing hæmatozoa mixed with normal saline solution, taken immediately after death from three specimens of "*Rhynchobdella aculeata.*" Baum (Hindustani) Warm (Marátha). A raised tumour followed at the seat of the injection of blood, which was tense and tender on manipulation. It continued to increase in size until the 15th, after which it became gradually reduced and finally disappeared. No hæmatozoa were discovered in the blood. The *Temperature* which at the time of inoculation was sub-normal, 36·2°C. (97°F.), commenced to rise on the 14th August, and attained a maximum of 38°C. on the evening of 20th. It then gradually fell until death which took place on the evening of the 25th. Temperature 35·2°C. (95·3°F.).

Autopsy.—There was an entire absence of any pathological changes referable to the injected fish blood.

Horse No. XLIX.—Black Mare. This animal was subcutaneously inoculated on the 15th October 1891, with a few drops of blood containing hæmatozoa mixed with normal saline solution. The blood was removed from the hearts of several specimens of the "*Rhynchobdella aculeata*" immediately after death. Some swelling and œdema followed at the seat of inoculation on the morning of the 16th, which continued to increase in extent until the evening of the third day, the 17th, and then gradually disappeared. As no symptoms had supervened up to the 29th, and the blood, during the whole time, had been free from hæmatozoa, the animal was re-inoculated with blood obtained from a fish of the same species as that used on the previous occasion. On the morning of the 30th well marked petechiæ were present on both the conjunctival membranes, and there was some swelling and œdema at the seat of inoculation, which latter rapidly disappeared in the course of 48 hours. Seven days later a muco-purulent discharge was observed to escape from the right nostril, and continual gurgling was present in the intestines. Between the 9th November and death, which occurred on the morning of the 16th, the animal was observed to be losing flesh; there was a yellowish tinge of the visible mucous membranes, and a continual discharge from both nasal passages. At the same time there were fresh crops of large petechiæ invading the membranæ nictitantes. During the last few days the animal gradually became weaker and the appetite fell off.

The *temperature* between the 15th and evening of the 28th of October oscillated between 38·6°C. and 36·5°C. After re-inoculation on the 29th October, the temperature was 39°C. on the evening of

the 30th and midday on the 3rd November; and from the morning of the 4th, gradually rose, attaining 40·5°C. on the 7th, and 40·4°C. and 40·5°C. on the 12th and 13th respectively. It fell, however, nearly 2·5°C. on the morning of the day previous to death, but again registered 41·3°C. by midday on that date. Death occurred at 2 A.M on the 16th November.

Autopsy at 10 A.M.—Body emaciated. Tissues all more or less tinged a yellow colour, and large petechiæ are present on the conjunctivæ. *Thorax*, free from fluid and pleuritic adhesions. *Lungs.*—The superior surfaces of the organs presented a variety of colouration varying from pink to reddish-yellow, blue and purple. There were numerous circular-shaped sub-pleural extravasations especially invading the posterior half of the left lung. The apices were the seat of localized emphysema, and there was a wedge-shaped area of 6 or 7 square inches in extent symmetrically placed on the superior surface, and anterior portion of both organs—eight inches from the apices. *On section* the consolidated portions of lung were covered by a layer of yellow exudation which dipped down between the lobules for the most part distinctly isolating one lobule from another. Fluid blood exuded from the cut surfaces of the organ, especially the posterior portion, but to the naked eye the tissue presented a healthy appearance. *Pericardium* contained two ounces of an amber-coloured fluid. *Heart.*—External surface presented several patches of sub-pericardial extravasation, the most extensive being 1·5″ × ·75″ in extent, which were found to invade the muscular structure to a limited degree. *On section*, right side contained clots which varied in colour from yellow, orange, red to green. *Right auricle* presented a healthy appearance. *Right ventricle* was the seat of numerous sub-endocardial extravasations. *Left auricle* presented a healthy appearance. *Left ventricle*, walls hypertrophied, contained a few clots, and a few sub-endocardial extravasations. *Liver* enlarged. Tissues appear healthy. *Spleen* enlarged, to more than three times the normal size. The tissues were firm, and there were a few sub-capsular petechiæ. *Kidneys* pale, but both organs presented a healthy appearance. *Stomach.*—Cuticular portion healthy. Villous portion presented a tumour (Spiroptera) near the line of demarcation, otherwise healthy. *Small Intestines.*—Numerous ecchymoses were dotted over the surface of the whole length of mucous membrane. No ulceration. *Cæcum* healthy. *Colon* presented several patches of congestion. No ulceration. *Rectum* healthy. *Bladder* healthy.

Two Guinea Pigs were inoculated with blood serum taken from the jugular vein of this animal 10 hours *post mortem* but the results were negative.

Details with regard to the swelling which occurred at the seat of inoculation.

Horse No. XXXIX.—Inoculated subcutaneously with small quantity of fish blood containing hæmatozoa, mixed with 0·6 per cent. salt solution. Swelling at the seat of inoculation appeared on the second day and increased in size up to the 4th, when it measured 3·25 inches in diameter. It then remained stationary until the 7th day, when it commenced to decrease. No hæmatozoa were observed in the blood, but the animal succumbed on the 15th day after inoculation.

Horse No. XLIII.—This animal was inoculated with blood containing hæmatozoa, mixed with 0·6 per cent. salt solution. Swelling appeared at the seat of the injection on the 2nd day, and increased during the following day. The swelling remained stationary as to size on the 4th, but commenced to decrease on the 5th day.

Subcutaneous inoculation and re-inoculation with soiled fish blood.

Horse No. XLIX.—(*i*) Inoculated with fish blood containing the hæmatozoon; swelling at the seat of inoculation appeared on the 2nd day, increased until the evening of the 3rd, then subsided, on the 5th day all signs of it had disappeared. (*ii*) Re-inoculated as in the first instance, swelling on the 2nd day. On the 3rd day diminished, and finally disappeared on the 5th.

Horse No. XLVII.—This animal was inoculated (*i*) with blood containing the hæmatozoon, mixed with salt solution. Swelling at seat of inoculation appeared on the 2nd, and continues until the 4th evening, then subsided. (*ii*). Re-inoculation as in first instance, swelling increased to 4th evening, and then subsided. Slight thickening until the 18th day. (*iii*). Inoculation with fish blood a third time. Considerable swelling at seat of inoculation on 2nd day. Next day subsided. (*iv*). Inoculated with 1·0 c.c. of Horse Surra blood swarming with hæmatozoa. A swelling 1¼ inches diameter, appeared on the 3rd day. This had increased on the 5th day to 7″ in length. Reduction in size and tension occurred on the 6th day and hæmatozoa were first observed in the blood. The animal succumbed on the 20th day of the disease.

Table XLIX.

Experimental Cases.

Appendix No.	No.	Kind of animal inoculated.	Fluid used for purpose of inoculation.	Quantity used for purpose of inoculation.	Fluid used taken from what animal.	Date of inoculation.	How administered.	Inoculation with fluid taken *ante mortem*.	No. of Hæmatozoa present in fluid *ante mortem*.	Inoculation with fluid taken *post mortem*.	No. of hours fluid taken *post mortem*.	No. of Hæmatozoa in fluid taken *post mortem*.	Result of inoculation positive or Negative.	Date of 1st appearance of Hæmatozoa in the Blood.	No. of days after Inoculation 1st appearance of Hæmatozoa in the blood.	Result of Inoculation.	Date of Death.	Days between inoculation and death.
			With 0·6 per cent. Salt Solution.		(Rhynchobdella aculeata.)													
I ...	XXXIX.	Horse.	Blood ...	few minims ...	Fish	11 8 91	Sub-cutaneous inoculation.	...	...	P. M.	Immediately.	Few.	N.	...	...	Death...	25 8 91	14
	XLIII.	„	„ ...	„ ...	„	22 9 91	„ „	...	...	P. M.	„ ...	Few.	N.	...	...	„ ...	23 11 91	62
II ...	XLIX.	„	„ ...	„ ...	„	15 10 91	„ „	...	...	P. M.	„ ...	Few.	N.	...	...	„ ...	16 11 91	32
					„	29 10 91	„ „	...	...	P. M.	„ ..	Few.	N.	...	...			
III ...	XLVII.	„	„ ...	„ ...	Barbus carnaticus.	15 10 91	„ „	...	...	P. M.	„ ...	Few.	N.	...	...	...	...	...
					„	29 10 91	„ „	...	...	P. M.	„ ...	Few.	N.					
					„	19 11 91	„ „	...	...	P. M.	„ ...	Few.	N.					
				1·0 C.C.	Horse LV. ...	9 3 92	„ „	A. M.	S.	...	„ ...	...	P.	14 3 92	5	Death..	29 3 92	20